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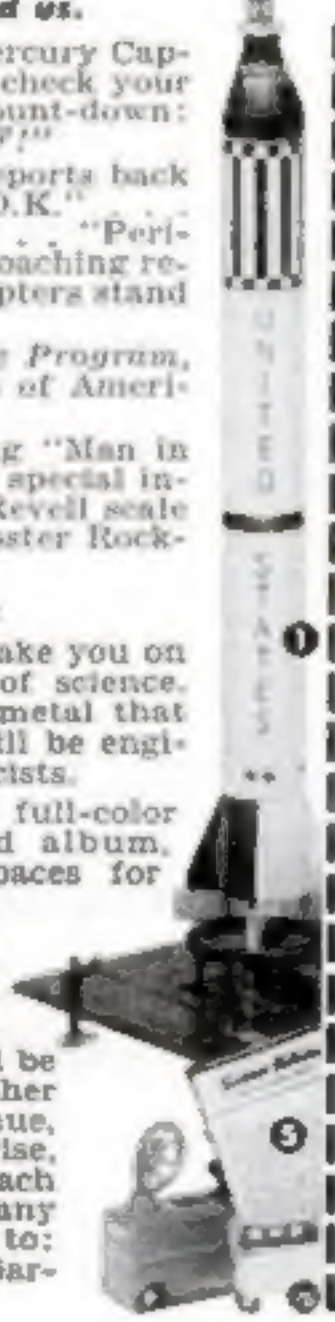

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Popular Science

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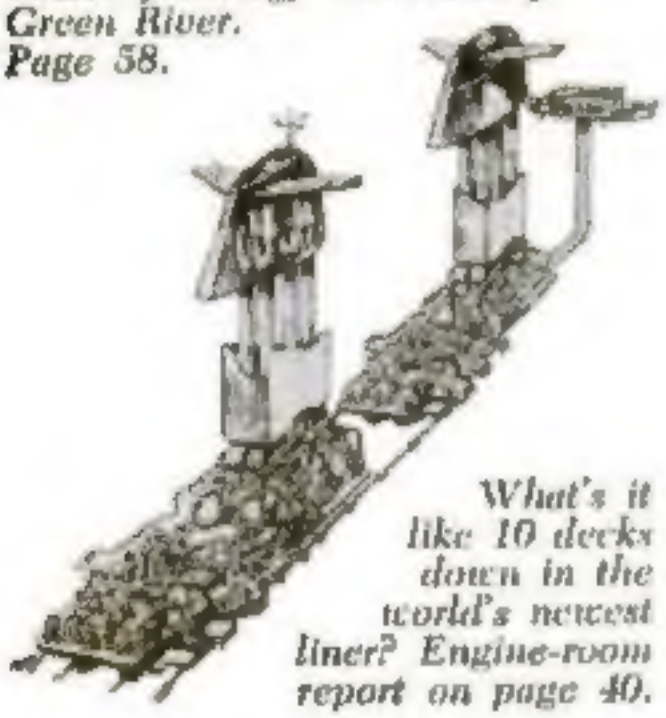
MONTHLY

August 1962

Cover painting by Bob McCall

Come along with a PS test driver on this jet ride down Utah's foaming, boat-busting Green River. Page 58.



What's it like 10 decks down in the world's newest liner? Engine-room report on page 40.

Step right up with your questions on space. Our man will give 'em a whirl. Page 48.

POPULAR SCIENCE 90th YEAR SPECIAL

PS readers talk back

A Real Hardback

The camping tips in the travel section ["Your Car and Your Vacation," May, p. 109] tickled me. While noticing all the comforts of home—including portable television sets—that so-called campers head out with today, I wondered why they leave home. Why not just tune in the home set to a good Western with the right scenery and use your imagination? When I was a kid, we went camping for real, with our things carried on our backs. None of our fishpoles ever had a motorized reel—or even a reel. This was true camping.

PETER LEGON, Malden, Mass.

Come On In, the Hearing's Fine

When something like FM stereo ["What You'll Want to Know About FM Stereo," May, p. 78] filters down out of the realm of audiophile ritual into the clear language of PS, it's really here to stay. Congratulations on an excellent piece.

Although we weren't included in the list of stations contemplating stereo broadcasts, our target date is now July 1.

TIMOTHY AHLSTROM, Gen'l Man.
WUFM, Utica, N. Y.

Lighter Fluid a Friend in Need

Let me suggest four additions to your excellent list of emergency-kit items ["Off-Highway Driving," May, p. 110]: A roll of paper towels, a can of waterless hand cleaner, a good spare cigarette lighter, and a fresh can of lighter fluid.

There can be lots of reasons why a car motor won't start, and that's the reason for that last item. If you can see that the carburetor isn't flooding, it saves time to lift off the air cleaner and give it a squirt or two of lighter fluid. If the engine then starts, but dies almost immediately, you know fuel isn't getting through. If it doesn't start, check the spark. But *old* fluid or gasoline may not work; my garageman proved this by giving me fresh gas for the purpose when I hadn't been able to start the motor after a few days out of use. It did the trick.

ARTHUR F. MILES, San Diego.

Recognition Noted and Given

We reacted with mixed emotions to "World's Biggest Robot" [May, p. 60]. We were delighted that the project appeared in PS, but disappointed that General Mills' role in development of the Beetle was not recognized.

I'm certain that you'll agree that the mechanical arms are among the most "exotic" features of this futuristic vehicle. You say that the steel hand "cannot feel . . . You can't tell whether you are crushing something or holding it so loosely it will fall." This is not correct. A grip-force indicator is mounted on the instrument panel. Aided by this indicator, an adept operator quickly develops the "feel" necessary to (as your lead paragraph stated) "pluck an egg off the top of a house."

LLOYD E. PEARSON
General Mills, Minneapolis.

The statement about the lack of "feel" came from Tex Scraper, who is reputed to be a very

CONTINUED

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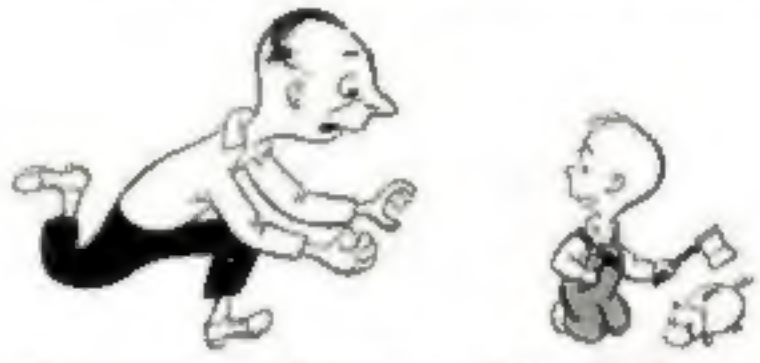
adept operator. Apparently the grip indicator is not, in his experience, a complete substitute for tactual sense.

Never Hammer a Hatchet

One of your pictures shows a wood carver ["How to Carve Your Own Totem Pole," May, p. 156] hitting a hatchet with a hammer. This is exactly what I did one day to an old log while splitting it for firewood. I was lucky. A chip of steel flew off the hatchet and imbedded itself 1½ inch in the muscle of my arm. Yessir, lucky: It could just as easily have hit me in the eye.

One should never hit two pieces of tool steel



together because they may chip. If the carver of a totem pole uses a brass or lead hammer, neither will chip.

C. W. Lautner, Youngstown, Ohio.

In Defense of Airships

The article on dirigibles ["The Biggest Birds That Ever Flew," May, p. 85] was historically interesting, and it was nice to see reference to Boston University's nuclear airship project.

I must take exception to your concluding paragraphs: You are comparing today's jet airliner with an airship of 25 years ago. An airship of modern design, to be sure, would cost more than the airplane, but it would cross the Atlantic in 30 hours (instead of 60) and would carry up to 400 passengers vs. the jet's 140—*three* times as many. The cost per passenger mile would be about the same for each.

Speed is not the only criterion in modern transportation, and the helium-filled airship of today would offer greater inherent safety than any other type of aircraft. Remember, the very technological advances which have made the modern jetliner possible would also have transformed equally the design of the rigid airship in the 25 years since 1937.

Prof. Francis Morse
Boston University, Boston.

. . . You give the impression that the Hindenburg was capable of hauling only 36 passengers. On her last trip, she carried only half her normal passenger load because only that many people took space. The crew was increased to 60 on this flight because there was room for them, and they could use the experience.

Also, your remark on the similarity of airships and dinosaurs is far from the mark. The

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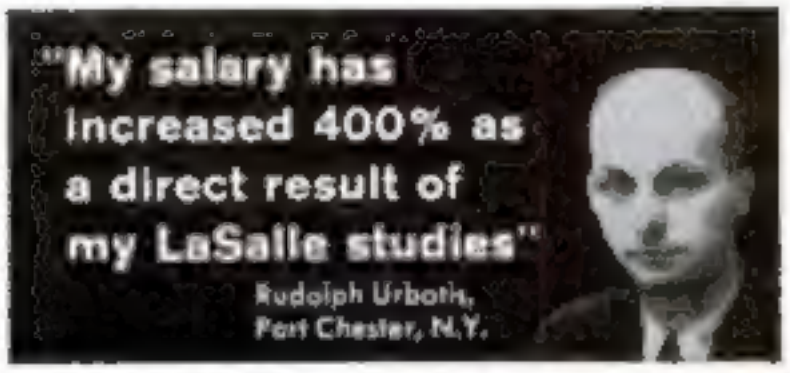

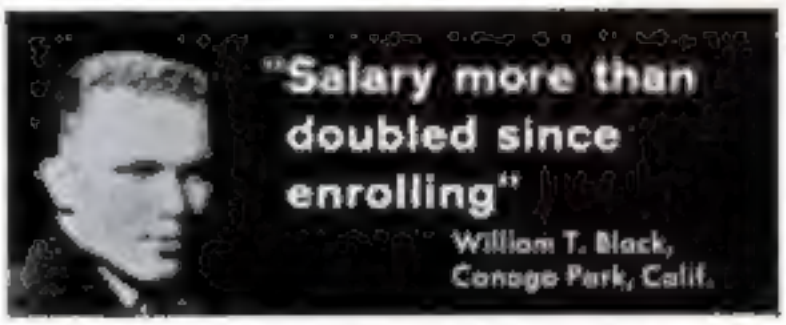

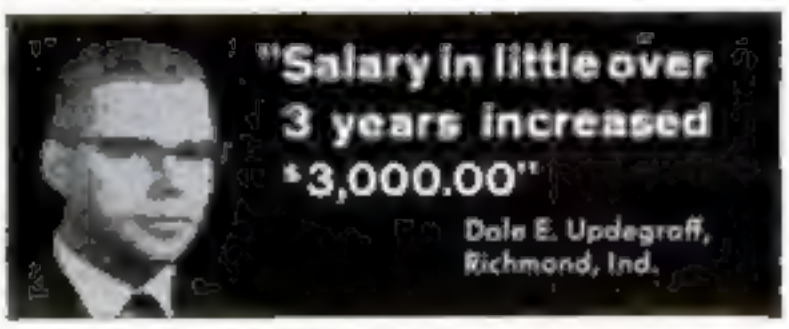

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dirigible is a lot more likely to return. There is a lot of activity in lighter-than-air craft right now.

J. D. Bisio, Wilmington, Del.

Keeping the Infantry Unwrinkled

The picture of the "stand-up bus" ["Picture News," Apr., p. 50] to keep the uniforms of the Army's First Brigade, Third Infantry, free

of wrinkles sure amused me. That Joe on the left with his foot propped up on a wheel housing has his leg in the same position as if he were sitting down. Two others have their legs bent enough to make bags in their trousers. They might as well sit down.

J. C. Coquet Jr., Biloxi, Miss.

Bottle Babies

Just finished reading the fantastic article on Daniele Petrucci's work ["Now We're Growing Human Life in the Laboratory," June, p. 74], and found it most interesting. Being a biology teacher, I noticed one error: The male chromosome is Y and the female is X. You reversed these. However, I'll still give you and author Joan Steen an A on the report.

Herb Walden, Andover, Ohio.

Correct. Everyone should know that men are Y's and women cross.

. . . The article on growing human life in the lab was disgusting. You say Dr. Petrucci's "primary aim has been to develop transplantable tissue." To do this, he is creating, by experiment (he doesn't even know if it will work or not), human beings in a plastic jar on a shelf. If this isn't "creating babies," which he denies, I for one don't know what is.

If he took any natural infant, killed it, and removed an organ to put it into someone else's body, he would be guilty in any country of outright murder. Why should it be different with these unnaturally created infants?

John McGathy, Massapequa, N. Y.

Help Wanted for Motor Bike

In 1958, I bought a Marman Twin motor bike. I've burnt up a piston in it and can't get parts for it. The motor is a two-cylinder, horizontally opposed two-cycle. Can any reader tell me where to get parts and a clutch?

Fred Kriec, Fort Branch, Ind.

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The Horsepower Race:
They're Off and Running Again!

IT WAS sheer coincidence that I happened to be talking about 1963 models in the office of a top engineer at Ford when a messenger handed him a memo from the boss. Mr. Henry Ford II, the announcement read, had just "withdrawn" his company from the automobile industry's ban on stock-car racing.

Mr. Ford, President of the Automobile Manufacturers Association, merely said out loud what everyone else already knew: The racing ban has been a dead letter for quite a spell. The literature on the Dodge 413 says, in effect, that you can drive it in the street if you *want* to, but it's really built for drag strips. And hotted-up versions of many makes have been supplied to the tracks by dealers and groups of engineers—evidently with substantial, if silent, support from the factories.

Why return to racing? The answer is easy. Performance sells cars. Pontiac set sales records after it set track records. Plymouth's "moment of truth" advertising boasts about a testing laboratory's comparison with Ford and Chevy; of the ten categories, six relate mainly to racing. Ford itself has been distributing a yellow-paper booklet entitled, *Important Facts About Your New 1962 Ford High-Performance 406*. Inside are tips on using a 406-hp. Galaxie for "drag racing or other extremely competitive events," and some exotic parts lists (manifold spacers, heavy-duty shocks and springs).

Personally, we like stock-car racing and we're glad to see the car makers openly taking part in it. Racing is a good sport. The factories may pick up some sideline business from it, their engineers get fun out of it (and might even learn something useful). And you can't expect them to refrain from boasting about their successes. Every car buyer wants to believe that his choice has more of everything—power, speed, engineering, style, comfort, utility. This kind of wish-fulfillment rarely troubles anyone. No harm is done if a fat and fortyish woman thinks that, just because she uses French perfume, she is as irresistible as Zsa Zsa Gabor. Still, that's not quite the same as suggesting to her slow-reflexed husband that, just because he bought a high-performance bomb, he can drive like Phil Hill.

Robert P. Crowley

EDITOR

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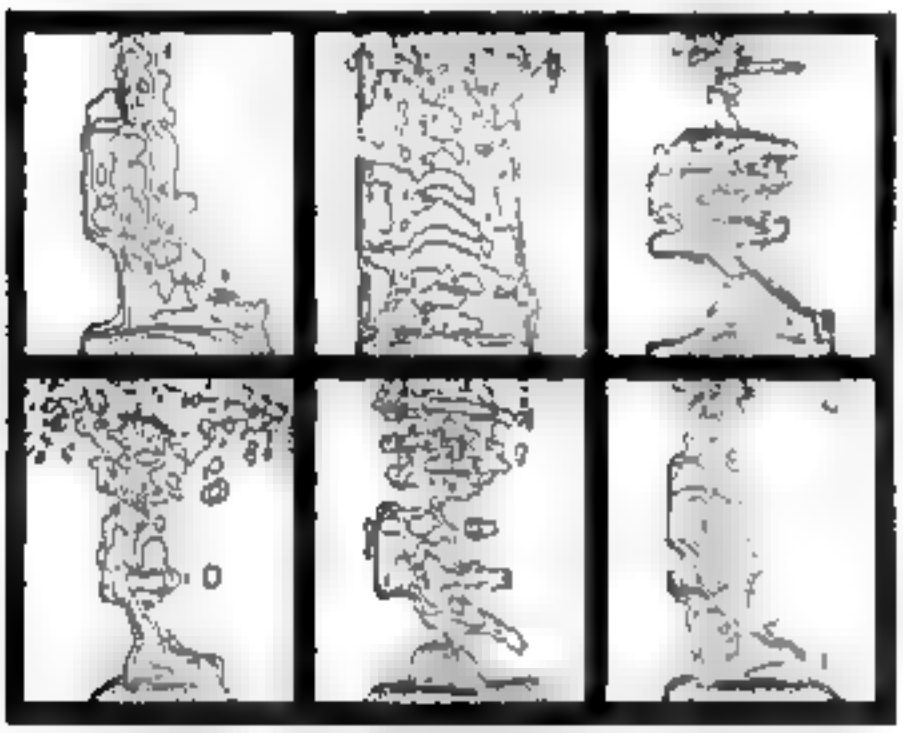
The march of SCIENCE

By Martin Mann

Your voice gives you away

"Voiceprints" will identify people almost as decisively as fingerprints, reports Lawrence G. Kersta, a tweedy, bearded acoustical expert at Bell Labs. Kersta's voiceprints are electronic recordings that graph the pitch and loudness of the sounds of a spoken word. These patterns turn out to be distinctive for each person. The voiceprint of your pronunciation of "the" looks different from anybody else's. And what's more, it always looks pretty much the same no matter how you try to disguise your speech; even if you talk with your mouth full of marbles, your "the" is still recognizable as yours. In tests, voiceprints could be matched to the speakers correctly 97 times out 100.

Which voiceprint has the twin?



Two of these voiceprints of the word "you" were spoken by the same person. Can you match them? (See end of "March of Science")

Kersta suggests that voiceprints might be classified and filed like fingerprints for a national identification system. They might also be valuable in military intelligence: By eavesdropping on radio communications, voices could be tagged in order to follow the movement of specific units from place to place. (A similar scheme, based on the unique characteristics of a Morse-code operator's "fist," has been used by the Navy to keep tabs on the location of ships at sea.)

Vitamin drops to stop tooth decay

Parents who want to save their children from the dentist's drill (and themselves from the dentist's bill) can now give the kids decay-preventing fluoride with the daily dose of vitamin drops. Upjohn's new Adeflor is similar to the vitamin mix that doctors order for nearly all youngsters, but has been spiked with sodium fluoride (no extra charge for the fluoride, but a prescription is required).

Fluoride prevents tooth decay most effectively when mixed into town water supplies, but this method—warmly endorsed by dentists, physicians, and government agencies—has been blocked by vociferous zealots (their arguments are complex and often devious). Such opposition has deprived millions of children of the protection of fluoridated drinking water and the new Upjohn drops serve as a stopgap for them.

CONTINUED

Better crops with petroleum

Esso researchers have turned up a neat new way to make oil work for farmers. They mix petroleum resins with water and spray the emulsion (by hand or from a tractor) onto the seedbed. The black emulsion coats the earth, forming a mulch that absorbs solar heat to warm the soil and also slows evaporation to hold moisture in the soil. The technique is still experimental, but some farm yields have been doubled in early tests. Crops also ripen earlier—in Arizona cotton was successfully planted two to three weeks earlier than usual. After harvesting, the mulch is plowed under (it improves soil structure).

Missiles to attack forest fires

The Forest Service has come up with a peaceful use for guided missiles: put out fires. It is testing a radio-controlled glide bomb loaded with 100 gallons of chemical extinguisher. The missile could be launched from an airplane, steered into the flames by remote control, and rigged to dump its load before hitting the ground. The big advantage is safety: The launching planes could fly high above the fire instead of bombing the blaze directly from tree-top level, the way they do now. (For an on-the-spot report of this operation, see page 82.)

Press agents outdream engineers

The way it read in *Time* magazine, the recently opened stadium in Washington, D.C., inaugurates a new era for baseball and football fans. According to *Time* magazine, it has a boat landing, a helicopter pad, outlets for electric blankets, air-conditioned dugouts, a special jail for disorderly fans, and one of the most modern scoreboards around. Impressed, we sent our man Markovich down to get the details of this 20th-century marvel. His report follows:

"There was no boat landing. Its con-

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struction hadn't been begun, and no one seemed sure it ever would be. The heliport was a little patch of grass in back of the ball park. Occasionally a police copter surveying traffic comes down to cool its oil. No passenger service. The usher thought that somewhere there might be outlets for electric blankets. 'Somewhere in the mezzanine,' he guessed, though he didn't know just where. Electric blankets? You have to bring your own. The dugouts *were* air-conditioned; a few outlets in the ceilings half-heartedly pumped out wisps of tepid air. No one had heard of a jail for unruly fans; any obstreperous patrons are immediately carted off in the paddy wagon. The scoreboard may have cost a quarter of million dollars, as was reported, but was of routine design and operation.

"Even the hot dogs tasted lousy."

What makes juveniles delinquent (cont.)

Harvard Law School's famous husband-and-wife team of experts on young hoodlums, Prof. Sheldon and Dr. Eleanor Glueck, has now pinned down more of the causes of juvenile delinquency. Their new book (*Family Environment and Delinquency*, Houghton Mifflin, Boston) explains why many children of poor homes or drunken fathers grow up to lawlessness—but many others do not. There is rarely a single reason, the Gluecks point out, but a complicated combination of many reasons. For example, a boy with a father he dislikes has already one strike against him. But if he is also stubborn, jumpy, and acquisitive, his "unacceptable" father is an even worse handicap. And still more: Some of these factors are heavily influenced by the boy's physique while others (like stubbornness) affect husky and frail ones alike.

Matching voiceprints: Upper left and lower right were spoken by one person

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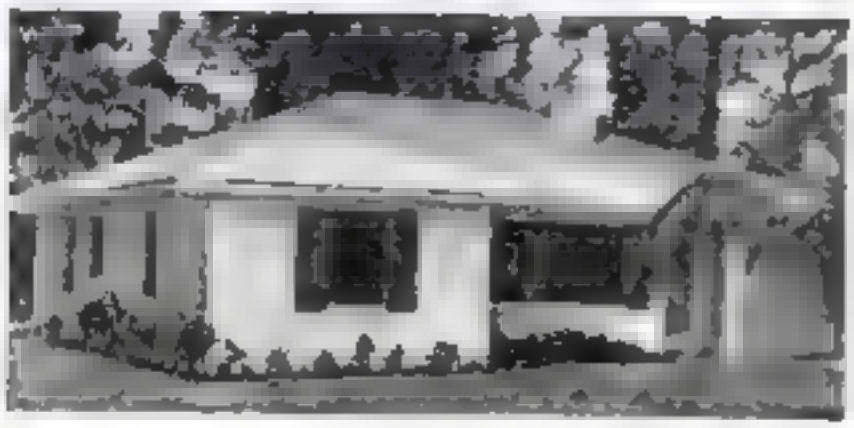

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SHOP TALK

By Sheldon M. Gallager

Can anyone identify this mystery tool?

The weird-looking object at the bottom of the page is a real can-you-guess-it teaser. It was sent in by A. C. Brockway, an Alabama reader, who says he found it among some old tools that belonged to his father. "Please don't tell me it's a reamer," he writes. "I've shown it to mechanics, machinists, construction men, and hardware dealers, and that's what they all say it is, but no one knows what it's for."

Okay, fellows, anyone really know what it is? The smaller arm (we won't call it a reamer) swings out from the larger one like a penknife blade. The cutting edges are slightly stepped to give different diameters, but aren't like a tapered pipe reamer. There's also what appears to be a wire cutter operated by closing the smaller tool against an anvil inside the big one. So maybe an electrician's tool? But they didn't need to ream conduit back in the old knob-and-tube days.

DeWalt branches out: A new line of saw blades

The DeWalt people, who make a lot of tools that use saw blades, will soon start marketing their own line of blades to go with them. More than 40 different types will be available for both DeWalt and other makes of radial saws, table saws, and portable circular saws.

Two-speed drills: A modern trend?

Now that there are several two-speed electric drills on the market, we asked Portable Electric Tools, maker of one of the latest, to pass along a few tips on the advantages of dual power. What they report makes good sense:

"Let's say you're doing some repair work on your car. You need a slow speed for drilling metal. But then you want to switch to grinding, sanding, or rotary filing, and for these you need a high speed. The two-speed drill lets you do both jobs with the same tool and at the most efficient speeds. You can also slow down for tough ma-

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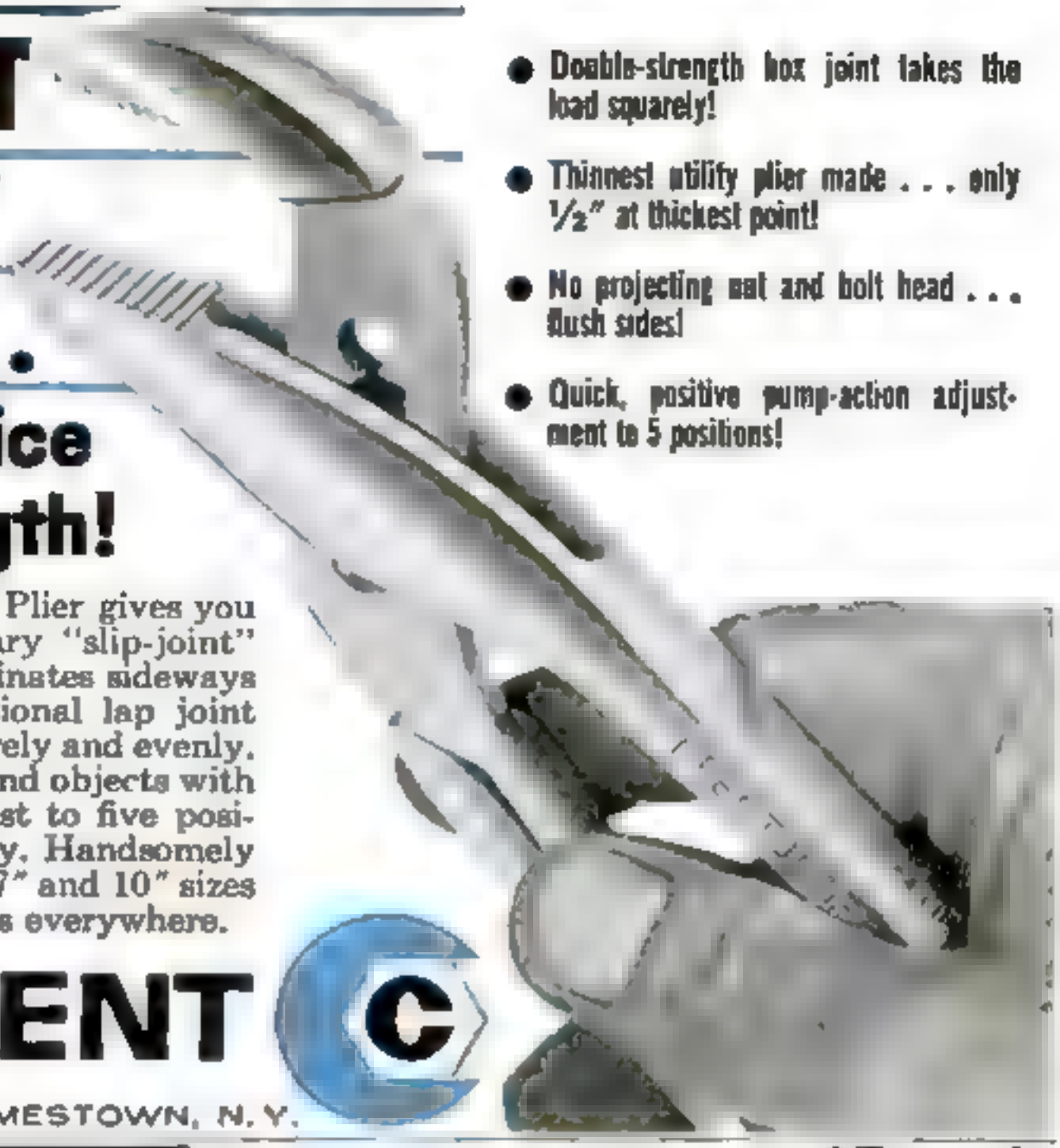

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SHOP TALK

terials like concrete, yet still have a high speed for the easy stuff. What you actually get is a portable hand tool with some of the versatility of a drill press."

Nicely put, we'd say. Portable Electric, which will sell its new two-speeders under the Shopmate label, will offer a ⅜" model with 800 and 2,400 r.p.m. and a ½" model with 500 and 1,500 r.p.m. Prices will run about $35 and $39 respectively.

Beefier battery for battery tools

The Exide people have come up with a smart idea for boosting power in electric mowers, drills, and other tools that run on 12-volt storage batteries. They've taken a heavy-duty aircraft battery and spruced it up for use by both manufacturers and home owners. First to come equipped with the new battery will be the Lectro Lawnshear mower, said to cut nearly half an acre of lawn in one hour on a single charge. The battery will sell for $41.85.

From Du Pont: A cement for plastics

Du Pont, maker of famous Duco cement, has added a new adhesive designed especially for repairing the many plastic articles now found in the home. It will bond all types of plastic except polyethylene and will also mend china and other household materials. A tube costs 69 cents.

New filters for air conditioners

If you've been hunting for filters to fit your air conditioner, here's an idea that sounds good. It's an aluminum-web filter that can be cut with scissors and washed for re-use. The trick: It's coated with a dirt-catching adhesive that rinses off each time you wash it. To renew the filter, you simply spray on fresh adhesive from a pushbutton can. Prices are $1.75 for the filter and $1.25 for the adhesive from Research Products Corp., 1015 E. Washington Ave., Madison, Wis.

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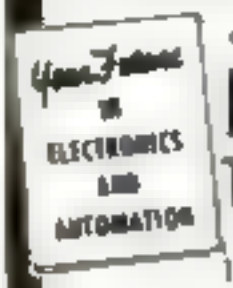

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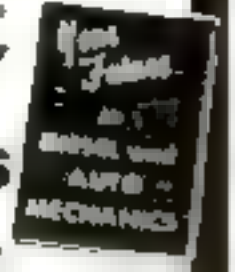

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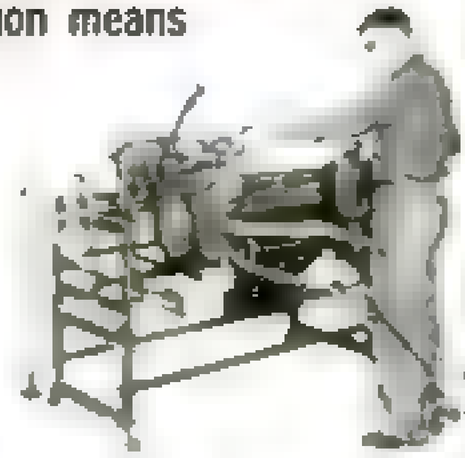

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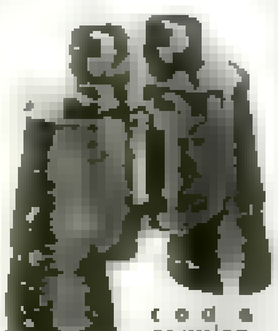

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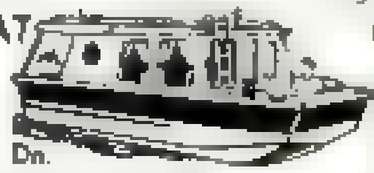

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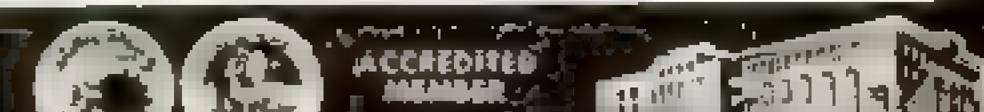

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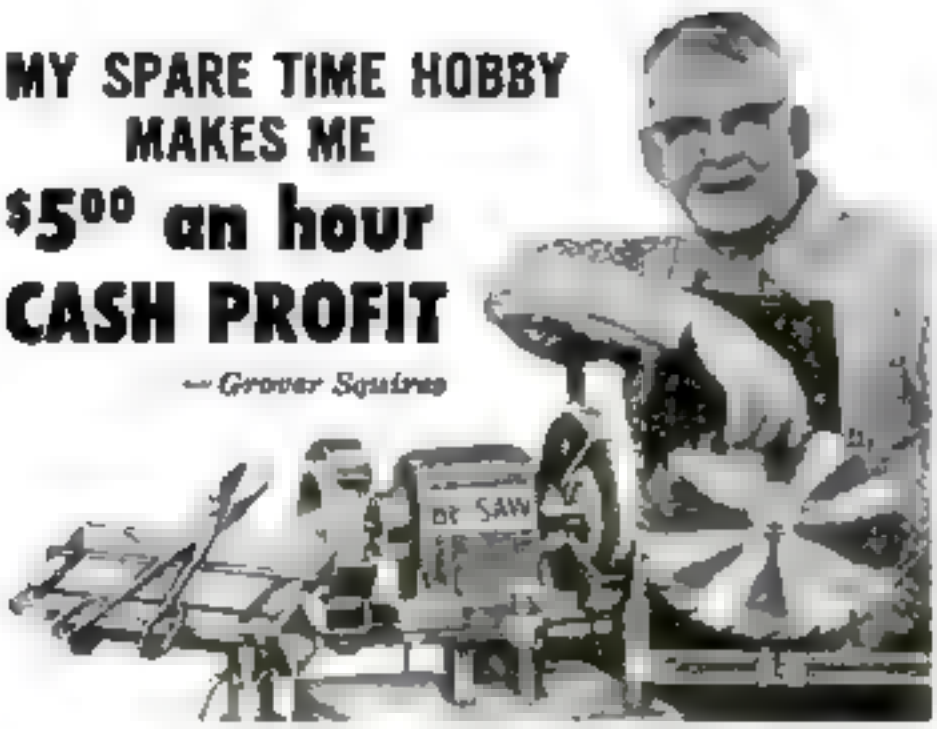

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Detroit report

More overhead cams

That new Willys engine with the overhead cam [PS, July, p. 73] has not gone unnoticed among the giants of auto manufacture. More are coming. Just when, though, is speculative. Chevrolet has an active testing program on overhead cams, and Ford is sure to follow.

Nothing new in European cars, the overhead cam was neglected here simply because it has been cheaper for U. S. engine designers to put in push rods for overhead valves than to devise a drive off the crankshaft for a high-up camshaft. But mechanically the overhead cam is attractive. By simplifying the valve train, it pretty well eliminates valve adjustments. It invites the use of solid instead of hydraulic lifters—which are finicky and inclined to clack in cold weather until they warm up. It speeds engine cooling by eliminating the push-rod holes in the block that disrupt water passages. Finally, the overhead cam provides a wee bit more power and miles per gallon.

A new Caddy engine

At long last, the elegant Cadillac is going to have a new engine. It has been 14 years since a basic change has been made in Caddy's sturdy V-8. Now and then refinements have been made, but the engine has remained essentially the one introduced in 1949.

Foundry and machining changes to produce the new engine for the 1963 cars are extensive. With no change in displacement or horsepower (390 cubic inches and 325 hp.), the engine will be a good deal lighter due to the thin-wall cast-iron construction pioneered by Ford Motor in the Ford Fairlane and Mercury Meteor.

Cadillac's move no doubt is a harbinger of things to come. Other GM divisions will lighten their power plants with similar designs. Incidentally, Reynolds Metals is strongly suggesting that it is about ready to introduce an alloy that would make possible the production of aluminum engines without cast-iron liners. It would reduce the cost of making aluminum blocks.

$$$ from odometers

If you had a feeling when turning in a rented car that the odometer had registered more miles than you actually traveled, you may have been absolutely right.

A Florida official recently told a national conference on weights and measures in Washington, D. C., that of 36 rental cars tested at random, the odometers of all but one registered high. Ten erred 6 percent or more, one an incredible 14 percent. Most odometers, incidentally, register 5 percent high because speedometers run high, and the odo runs off the same cable.

This isn't necessarily the fault of the rental agencies. If you will check the odo on a rental car against mile posts and report the error, the agency likely will deduct for the undriven mileage.

Move to disk brakes?

Since 1953, when cars fitted with disk brakes came in one-two-three at the Le Mans race, Detroit brake men have kept a watchful eye on those efficient stoppers. But no one found a way to lick the biggest objection to their use: cost.

Now Bendix Corp., U.S. licensee for the British Dunlop disk brake, is preparing a hard sell to American automakers, and baiting it with something that usually makes Detroit noses wrinkle with pleasure: an attractive price. Studebaker's Avanti is the only U.S. car rolling around at present with disks (they're supplied by Bendix); but insiders say that other brands in search of a sports-car image may soon go to them, too. Watch for Pontiac to make an early move.

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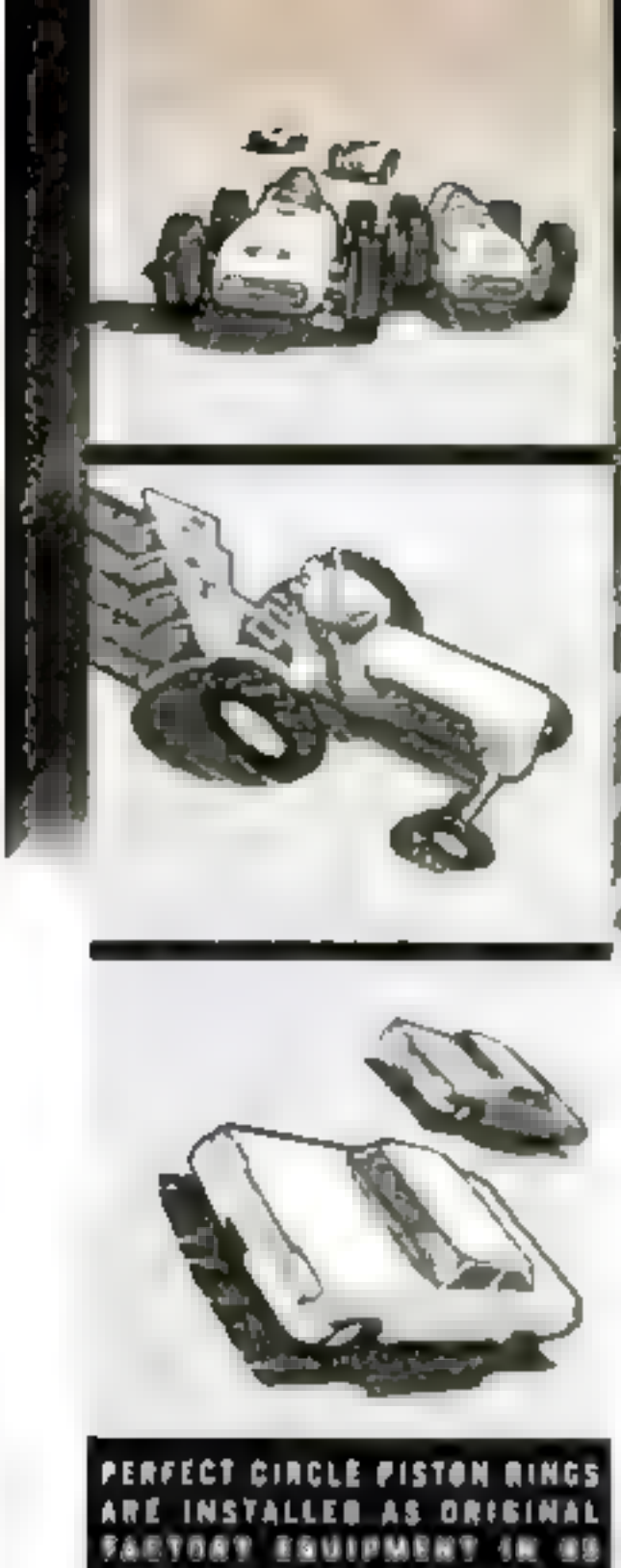

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THE WORLD'S TURNED UPSIDE DOWN

THERE'S A HOT NEW COMER UNDER THE HOODS OF TODAY'S WINNERS. IT WASN'T THERE YESTERDAY. TOMORROW? THE RECORD SPEAKS FOR ITSELF.

Records and Traditions Die Hard at the Brick Yard.

Old Timers looked twice when eight cars showed up for this year's Indy 500 with a new kind of spark plug under the hood. Such things just aren't done in winning circles. Three hours and 34 minutes later it was done. The Silver Fox, Rodger Ward, had his Leader Card 500 Roadster in the winner's circle and a new record of 140.293 mph. Teammate Len Sutton had a solid second to his credit. And smiling Eddie Sachs, who started so far back he couldn't see the starter's flag, had done the impossible. Driving close enough to the wall to carve his initials in it, he left everybody but Ward and Sutton in an insolent trail of exhaust fumes. All of the first three finishers broke the old track record. All of them thumbed their noses at tradition and ran with Autolite Spark Plugs under the hood. Accident? One-in-a-million fluke? Read on.

It all started at Daytona Speed Weeks. Five big races. Three new records. And a strange thing in common about all of them. The NASCAR Continental, 34 GT and sports cars take off. Three hours later Dan Gurney takes the checkered flag. Who finished behind him? Phil Hill, Stirling Moss and 31 others. Lift the hood of Dan's Lotus XIX. Outright heresy. Autolite Spark Plugs.

First 100 Mile Stock. Fireball Roberts romps. Speed (a world's record for 100 miles) 156.999 mph. Spark Plugs Autolite. Second 100 Mile Stock. Joe Weatherly's turn. Spark Plugs: Autolite.

The 250 Mile Modified National Championship. 54 "anything goes" tigers take off. By the half-way mark, all but 28 of them are in the pits. Odd. Every car left in the race is using Autolite Spark Plugs. Winner Lee Roy Yarbrough. Car: Modified '56 Ford. Speed: 146.723. Spark Plugs? Modesty prevents us.

The big one. The Daytona 500. Briefly, Fireball fried 'em. Speed: 152.529, the fastest speed for five hundred miles ever achieved in an automobile. Spark Plugs: Old reliable, what else?

Chaos at Charlotte. Nelson Stacy sets new world record for 600 miles. 125.552 Autolite equipped cars take 1st, 2nd, 3rd. Revolt at Rebel 300. Stacy again and his '62 Ford. Autolite equipped cars finish 1, 2, 3, 4, 5, 6, 8, and 10.

What's all this add up to? Simply this. Cars using Autolite Spark Plugs have won every major stock, modified and sprint car race since January 1.

All this might lead one to believe Autolite Spark Plugs are a must for race drivers. But what's that got to do with rush hour traffic in Cedar Falls? Here's the answer. Not in terms of "If racers use them they must be best," but in some rather technical details on how we build our spark plugs. We hope you'll read it through, it's important.

Let's start with compression leakage. To solve this problem racing spark plugs are heat sealed. So are aircraft spark plugs. All of them. Even the ones built by our competitors. The insulator is fused to the steel shell under heat and pressure. This is the most positive way known to prevent this leakage.

And because it is the most positive way, Autolite heat seals every single spark plug it makes. Doesn't everybody? Unfortunately, no. Only about half the standard automobile spark plugs sold are. So next time you plug those holes in your engine, make sure it's a tight fit. Ask for Autolite.

Another point—if you own an overhead valve engine (and 95% of you do)—about fouling in city traffic. We've done something about it. Built a new kind of spark plug called Power Tip. Has a longer electrode made of a special heat resistant alloy that reaches deeper into the fierce heat of engine combustion. Actually uses this heat to burn fouling deposits away. Autolite Power Tip is the spark plug that cleans itself while you drive. If deposits have your mileage on the run, give 'em a try.

Now that we've stated our case, we hope you're inclined to try our products. You'll be glad you did. And don't get us wrong. We've got nothing against tradition. In fact, we're starting one of our own.

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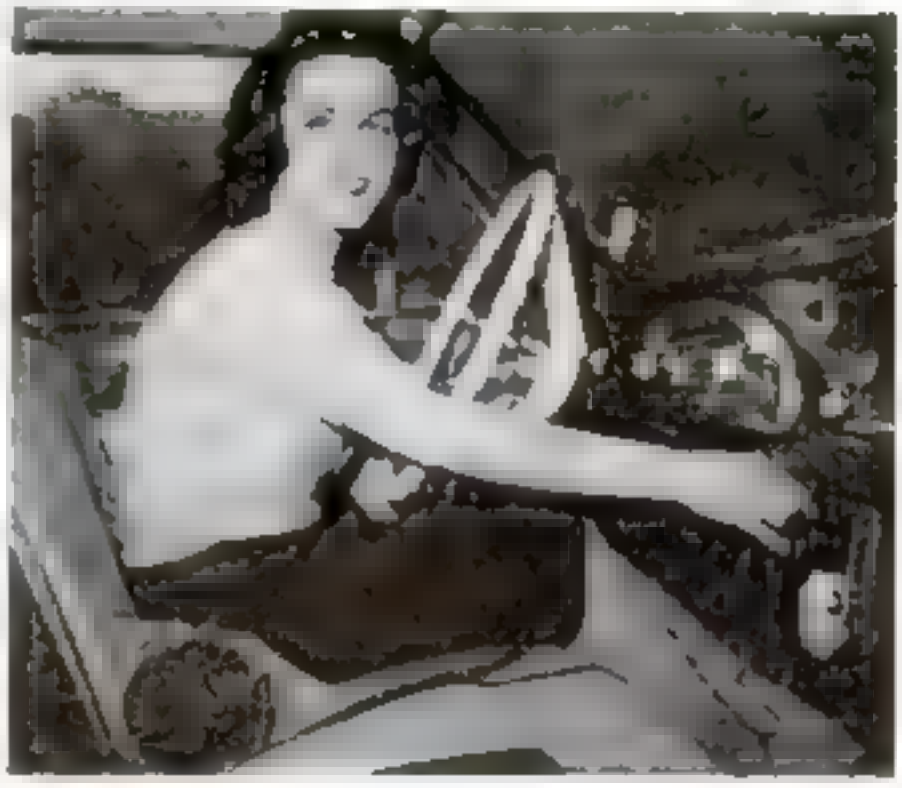
ROADSTER

New Jeeps, etc.

This and that: Willys Motors will have a whole line of new Jeeps in the showrooms this fall, including station wagons and small vans. The restyling will make the famous Jeep hard to recognize . . . Willys also is in the final stages of developing a small diesel engine that will have most of the features of its over-



The Fan-E-Fan

head-cam engine . . . Latest in cooling accessories for summer is the Fan-E-Fan (see photo), powered by a cord to the cigarette-lighter receptacle. It provides a two-m.p.h. breeze under and behind the driver. Made by the Hyman Co. of Fremont, Ohio, it's priced at $12.95 . . . Chevy engineers have concluded from their work with the supercharged Corvair Spyder that the standard aluminum Corvair engine in ranges of 80, 84, and 102 hp. can get along with one carburetor, too . . . A startling new steering device will be offered optionally on some '63 Oldsmobiles . . . And GM recently patented something else—a single-stick control for steering, accelerating, and braking . . . Ford's advanced-product study department has completed a project on skid control. Brakes are released automatically at the moment that a car starts a skid. No plans as yet to put the thing into production, though.

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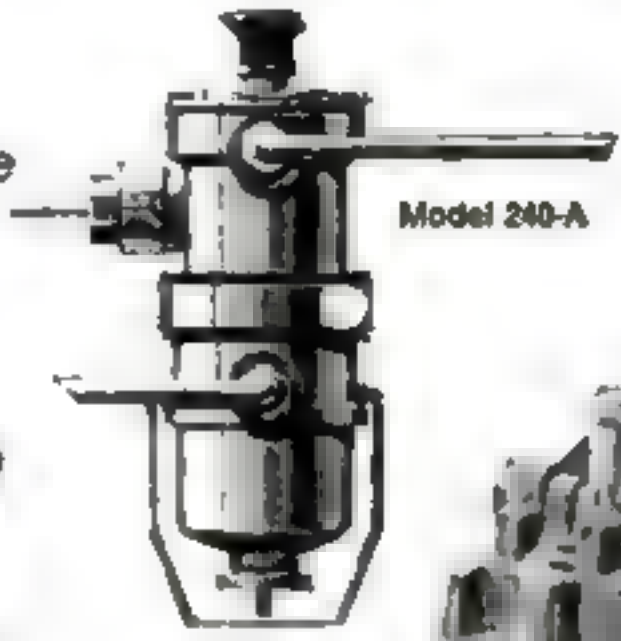

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1887 William James in an article on human instincts wrote:

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"**Hair of marked softness** or fullness seems a frequent accompaniment of artistic or literary genius. Thus the hair of Keats is described as 'clustering thickly,' that of Ruskin as 'luxuriant.' It is an interesting circumstance, too, that poets, artists, or literary men possess curly or wavy hair: Leigh Hunt (inclined to wave), Sir Arthur Sullivan (wavy), Mendelssohn (very curly), Gladstone, Shelley, Chopin, and Thackeray. The poet's ringlets seem a distinct fact in biography. The abundant hair of musicians as observed from the concert platform will also, in this connection, suggest itself to the reader."

1937 "**A whisker guide** has been invented to help motorists park. A bent wire extends six inches from the underside of the right fender and is soldered to a tin cylinder that acts as a diaphragm. When the wire scrapes the curb it sets up a warning vibration in the cylinder. The original model was made from piano wire and a tin can."

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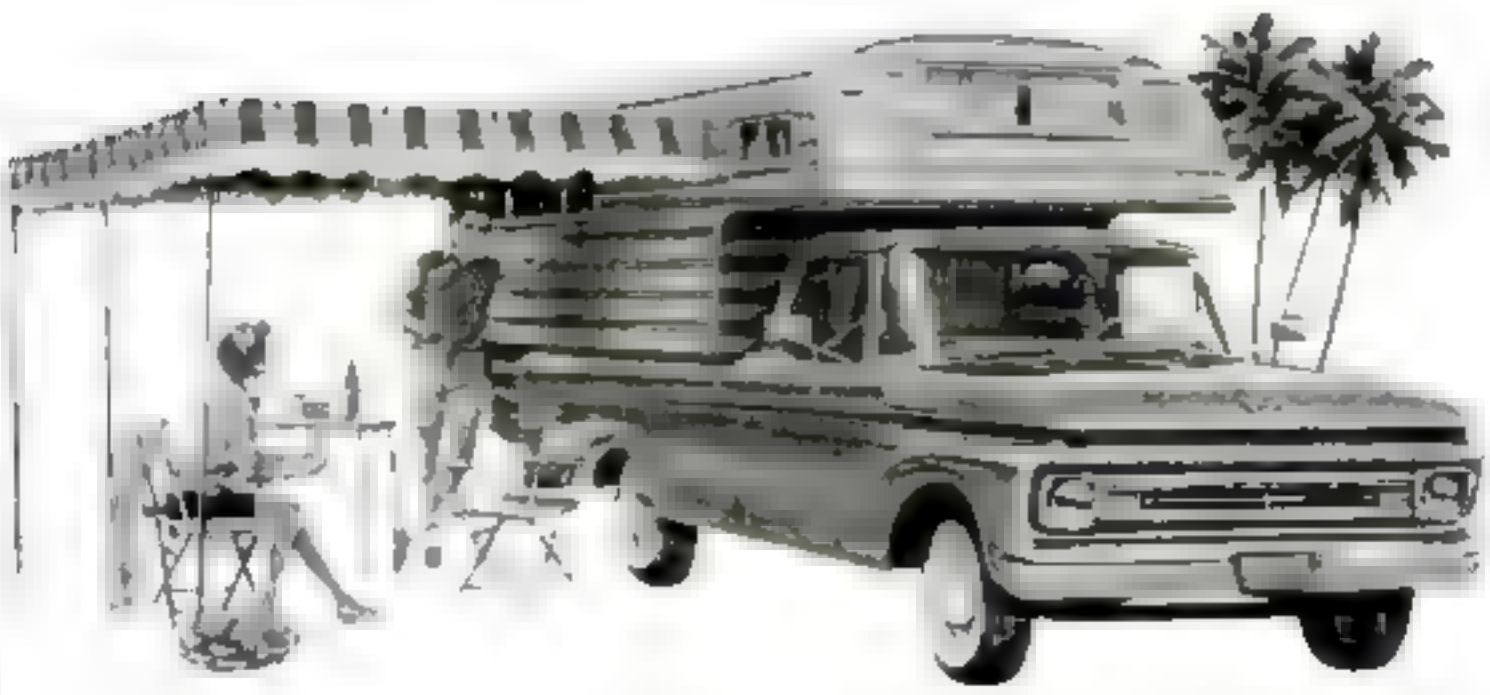

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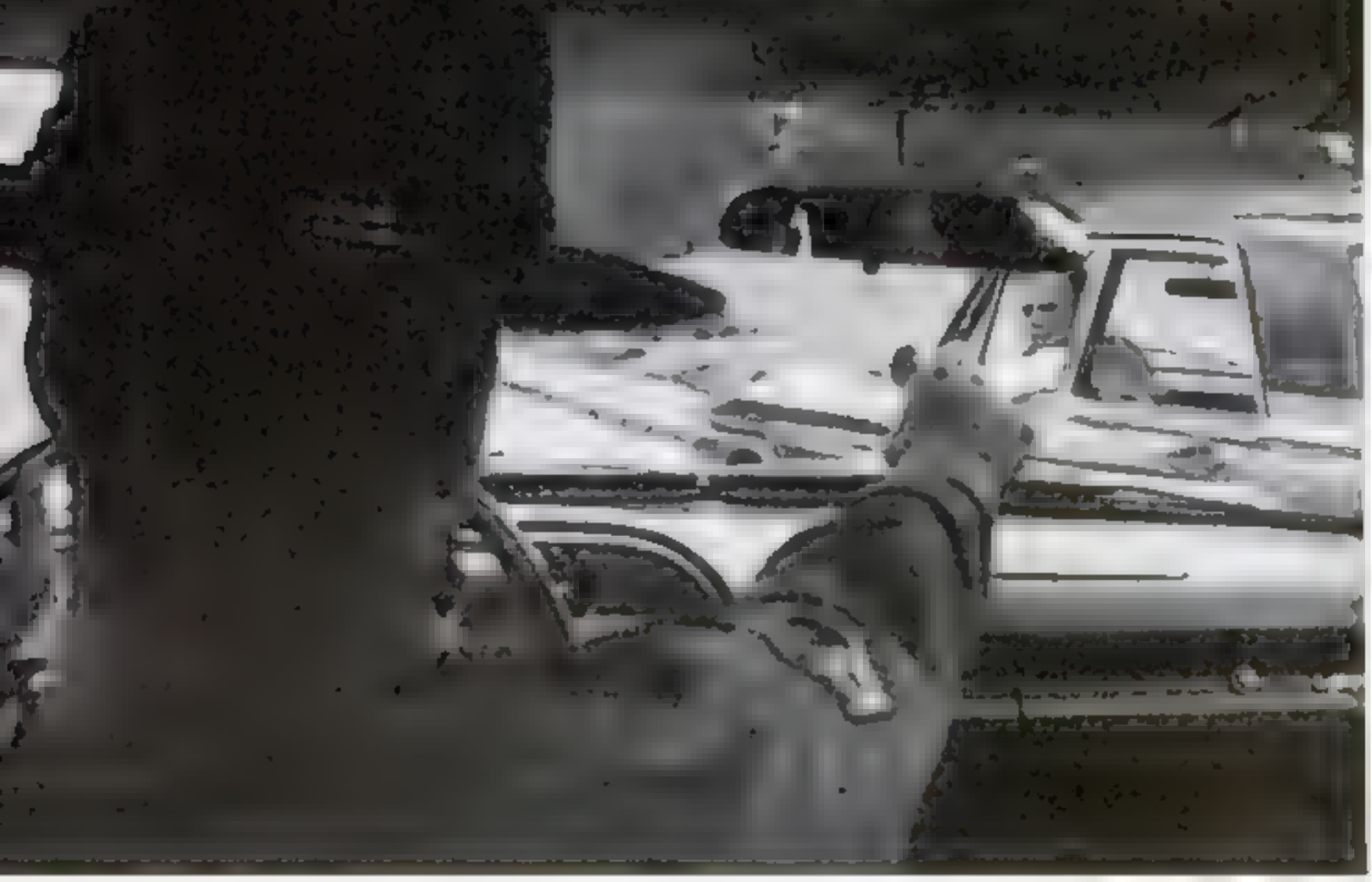
POPULAR SCIENCE Monthly

Could You Drive Like a Trooper?

Here's how North Carolina cops catch traffic violators quickly, efficiently, and safely



PHOTOS BY W. W. MORRIS

By E. D. Fales Jr.

WE SAW him coming like the wind, a pair of headlights quivering on the horizon. We were going south; he was coming north.

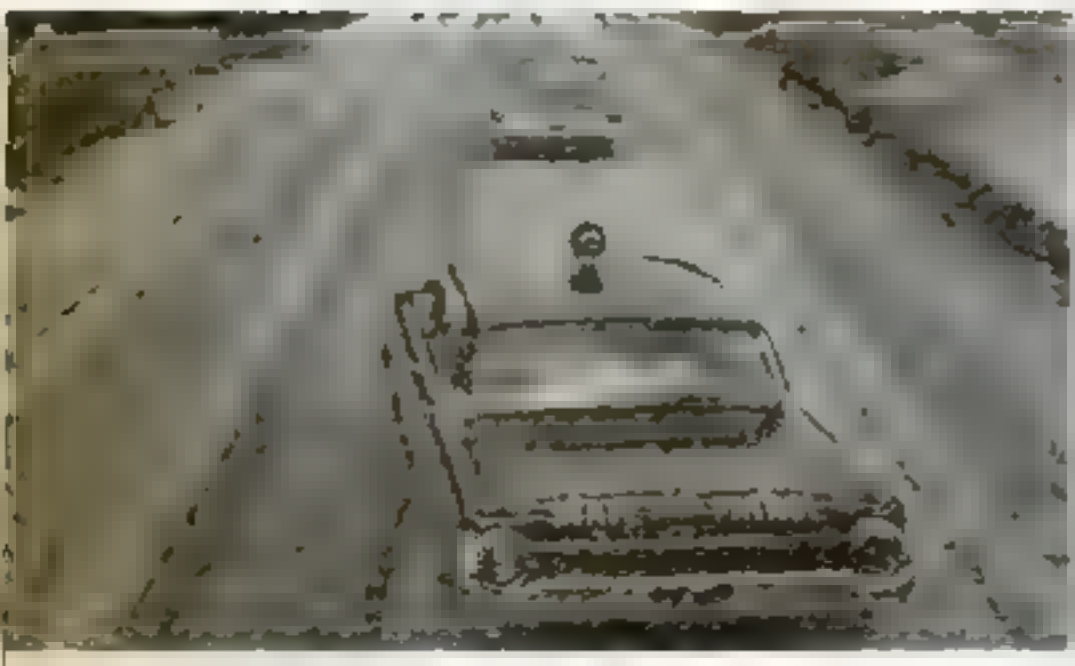
Whoom! He went by our patrol car on the other side of dual U.S. 401 near Fuquay, N.C. We'd just come through there and had seen late shoppers in the streets. In a few scant minutes, if he were drunk or a fugitive, he might roar into those streets without slowing down.

Trooper Earl Green said: "Guess we'd better get him first."

It was not a noisy, screaming turn—the kind you see on TV. It was tight, planned, and beautifully done. We came

CONTINUED

There's a right and a wrong way to pull him over. A mistake



RIGHT 1 Check road ahead to make sure it's safe. Start to pass from well back.

2 Pull up no farther than his rear bumper. Up siren or horn. Point to a safe stop.

WRONG 1. Here's what can happen if you pull abreast of car you're stopping.

2. Driver who may be drunk or reckless cuts sharply to the left in front of patrol car.

Wrong: Stopping too far behind a car means a long sprint if the suspect drives off fast.

out on the northbound concrete, ready to go—not on the far shoulder where we'd have lost precious seconds slewing and spitting gravel.

Even so, the other fellow was only a dim red spark far ahead when we blasted off. Under our hood was a real tiger: a 400-hp. Ford Police Interceptor. At first Green unleashed it slowly while our 15-inch "chase wheels" felt for a good grip. Then we had our traction, and Green wound up the tiger's tail.

What happened next was that we closed fast on three cars and a truck. The TV heroes would have turned on a siren and roared by, scaring hell out of three taxpaying drivers. But North Carolina patrols have discovered that at 55 m.p.h. a motorist often can't hear a siren until you're *alongside* his car—and if you blast by you may panic him into

may give him a chance to escape—or get you into an accident

3. Always stay behind the motorist. Make sure he pulls at least six feet off the road

4. Stand to the right of the cars, away from passing traffic, when interviewing a suspect

3. Unable to [illegible]

4. With the patrol car wrapped around a tree the lawbreaker is free to get away

a series of startled, slewing swerves.

So Green used no siren, but slowed. Trooper-style, he kept one foot "covering" the brake—hovering near it—if needed. (Some troopers use left-foot braking.) Then he blinked headlights rapidly. When he was sure they'd seen the flashes, he kicked down hard on the gas and started by.

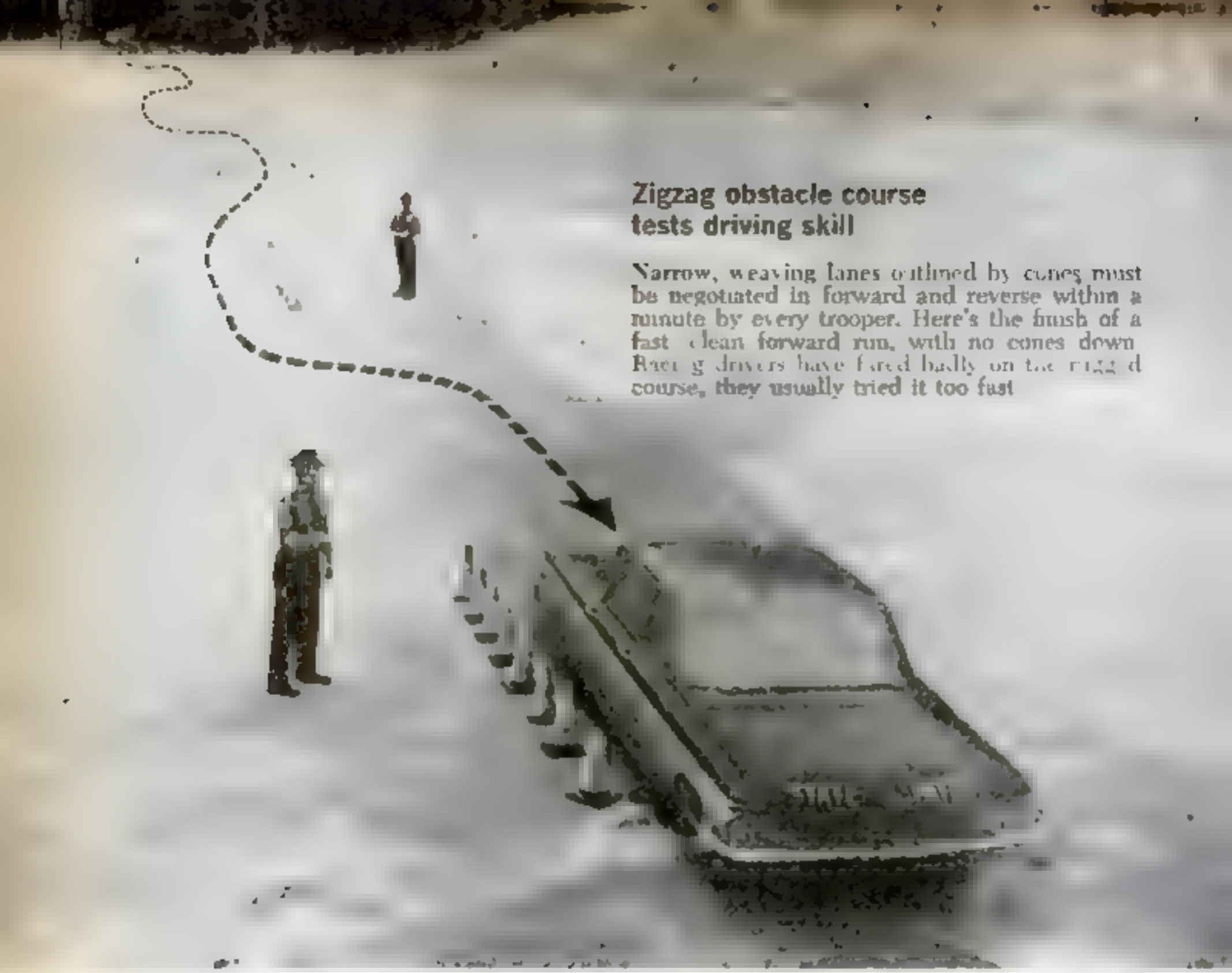
We dropped into passing range. When we came out, the three cars and truck were far behind and we were doing 90. As we went into high I tightened my seat belt. Clear road ahead. Dark fields. No cross-traffic. The car had that peculiar floating feel that says: 100 m.p.h. and going up. The seat back still thrust against me.

We took two curves that could have rolled an amateur. Under Green's control we never felt them. After that, our speed went up and I guessed it at 115.

CONTINUED

Wrong: Don't park in front of a car and walk into blinding lights. They could hide a pistol

Right: Park close in back, about three feet to the left to shield other car from traffic.



Zigzag obstacle course tests driving skill

Narrow, weaving lanes outlined by cones must be negotiated in forward and reverse within a minute by every trooper. Here's the finish of a fast clean forward run, with no cones down. Racing drivers have fared badly on the rigged course, they usually tried it too fast

The lights of the town glimmered ahead.

We came up on the hot one like a bullet. He was a very surprised driver when our headlights beamed in his rear window and he saw our red flasher. Then we threw out the anchor, and minutes later he was reading his ticket.

The art of staying alive. Such chases are becoming commonplace in many states in this day of hot cars. Could *you* drive that way if you were a trooper? Could you (1) stay alive and (2) not risk the lives of everyone on the road?

I've just come back from a strange new proving ground where you'd soon find out. It's the pursuit precision school of the North Carolina Highway Patrol. Here they're turning out some of the best drivers in the world. Even racing drivers think some of the skill tests

The school is the baby of a canny lieutenant named Ed Jones. He says that only *accurate* driving will keep troopers

Author clips a couple of cones going forward through course, then backs into a sad ending.

How would you steer during a fast chase? Position shown in center photo is correct, says Lt. Ed Jones, because it permits use of your shoulder muscles as well as the arm muscles.

alive—and guard the public. Jones has written a textbook called *Pursuit Driving* that has become the bible for police in many states and cities, even for Scotland Yard and the Canadian Mounties.

Jones lays great stress on fast precision turning, backing, and parking. In his courses, troopers learn to turn and park in half the time the average civilian needs.

"If you flunk our tests, as many hot drivers do," says Jones, "we block you out. You're not patrol material." If you pass, you get special instruction "to iron out the kinks." Then you're sent out on the road with such master pursuit-drivers as Green, to watch how it's done.

Finally, you get the wheel, and a night comes when you're told: *"Catch that car!"* Off you go on your first chase. If you're lucky, you won't make more than a couple of the 12 major mistakes in pursuit driving (see box below).

The training course dates back to an exciting night some years ago when a drunk ran Jones off a curve. Both survived, and the drunk scurried away on foot. Nobody had ever told Jones it was dangerous to chase a man on foot. His own instinct told him that, so he went right across the fields after him—*by car*. And caught him.

Right then Jones decided that this

[*Continued on page 168*]

Would You Make These 12 Chase Mistakes?

If you had to make a high-speed chase would you . . .

1. **U-turn** so fast you'd run off the road? (Amateurs often U-turn too fast, heeling and spinning.)
2. **Start** so fast you lose traction?
3. **Rely on the siren** to clear a safe track? (Drivers often can't hear sirens, and pedestrians, unable to place the direction of the sound, get confused.)
4. **Rush up too close** behind the car you're chasing, so you risk a smash if he hits his brake?
5. **Swerve into passing lane** so fast you drop a wheel off the left side?
6. **Pull up alongside the other car**—and find yourself trapped out *ahead* of him (a dangerous place) if he suddenly stops?
7. **Panic** the other driver into an accident by a sudden and unnecessary blast of siren or horn?
8. **Fail to turn on** your red blinker to warn other traffic?
9. **Get excited** and shoot at his tires, or bump his car, making yourself liable to arrest even though you're a cop? (Shooting and bumping are used rarely, and only against known, desperate criminals.)
10. **Fail to plan ahead** and pick a "safe landing field" to direct your motorist into?
11. **Stop more than 15 feet behind him**—so he might suddenly pour on coal and drive away, leaving you a long sprint back to your car?
12. **Fail to protect him** from other cars? The civilian's car should be parked with the left wheels at least six feet from the road. Yours, with red beacon flashing, should be parked *three* feet from the road—to overlap his car and protect him from other cars.

Water plumes and whistle blasts greeted the France as she arrived in New York on her maiden

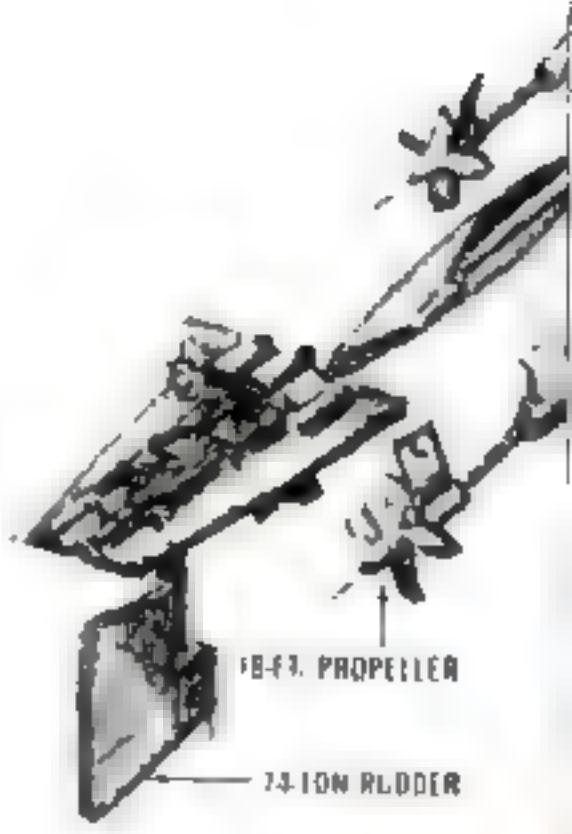
Inside the World's Longest Liner

A man who loves machinery takes you on a nuts-and-bolts tour, from bridge to boiler room, aboard the new 1,035-foot France

By Henry B. Comstock with sketches by the author

HALFWAY from Le Havre to New York, the world's newest, longest, and most gilded liner is plowing a white furrow through the night. It's the fourth crossing for the French Line's 1,035-foot France. Now completely broken in, this $80-million bid for the tourist trade is hustling close to 2,000 passengers toward the States at a vibrationless 32 knots.

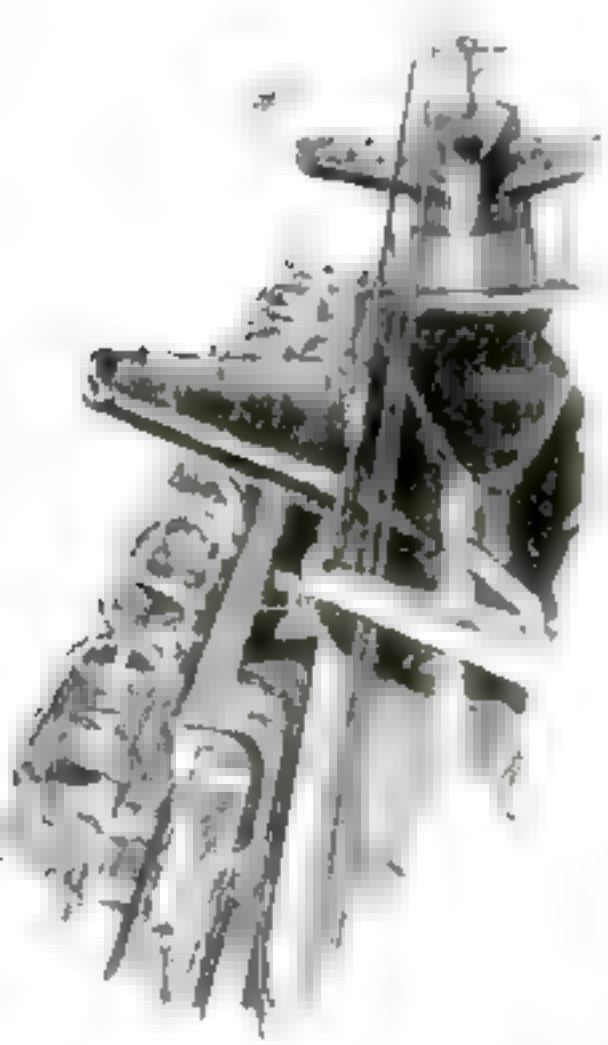
I'm standing alone on *le pont observation*. This is the France's highest deck—her twelfth. Set on the forehead of



voyage in February.

Distributing station [illegible] below controls and dispatches [illegible] 500 kilowatt electrical output. The vessels [illegible] diesel-electric generators [illegible] emergency supply circuit [illegible] diesels. A second [illegible] station would [illegible] were crippled

Radar mast with paddle-type scanners towers 90 feet above the observation deck. Integral crow's-nest has a five-by-seven-foot deck, providing ample room for a team of lookouts.



Crow's-nest view aft shows starboard ailerons of France's distinctive smoke-deflecting rigs, and a few of her 20 standard lifeboats. Combined capacity of these, plus two closed-cabin launches and a pair of plastic whaleboats, is 3,410 persons.

The last of the superliners? There's no hint of obsolescence aboard this ultramodern ship

the bridge, it's topped by a huge aluminum obelisk -the ship's radar mast. More than 170 feet above waterline, I can see the tricolor of France flapping at the Big Dipper. Just below, one of two radar scanners is probing for blips. In an electrically heated crow's-nest farther down, a lookout backstops the electronics.

Another lookout is swinging his arms across his chest on the wing bridge to my right. Without turning his head, he shouts: "'i, Monsieur Popular Science. 'ow goes the story you write about us?" Then: "*Attention!*"

I "attention" too late. An unusually large wave has just quartered against the knifelike prow of the France. A mushroom of spray hisses across the 80-foot-high deck. That's how fast you can enter a storm on a brisk ship.

I'm still shaking off the water when Second Engineer Noel Devillers, in white coveralls, lays a hand on my shoulder. "The Chief Engineer says you may wish to see the stabilizers activate. Follow me."

Devillers and I race past a battery of louvers blasting out some of the half-million cubic feet of air pumped through this sea monster's ventilating system every minute. Then we trot by the kennels, where 30 pooches are being pampered at 50 bucks a head. Finally, we drop to the bilge in one of the liner's 29 automatic elevators.

We reach the forward-stabilizer compartment just as four massive shafts slide out through the flanks of the hull. This eases two fins from their pockets. Each has a surface area the size of an average dining room—90 square feet. Devillers tells me a similar pair of fins is gliding into position in the compartment just astern. Both sets have been put in motion from the bridge.

As soon as the flippers are fully extended, four gyroscopes cut in. They're hardly bigger than quart jars. Their job is to sense the direction and progress of each roll of the ship. Then they trigger the machinery that angles the fins, like ailerons, to counteract it. With a mighty assist from the forward motion of the France, the hinged blades can reduce what would be a bilious 20-degree roll to a piddling three degrees.

"How about the fore-and-aft rocking—the *pitch?*"

Devillers grins. "The best device for that is a long hull. You know the length of the France, she can bridge three heavy Atlantic waves at one time. To this has been added a bulge near the bottom of the prow. Acting like a rocket nose, it, too, discourages the ups and downs."

Last of the golden galleons? The way I've been paged for this performance is typical of the help I'm getting. It started less than two weeks before, when I cabled an old friend, Raymond Agnieray, once Second Captain of the

Boiler room is one of two, both identical. Officer at control panel (right) stands amidship, facing bow. Engineer inspects oil-burner nozzle; rapierlike handles of others project from burner units on the boilerhead. When ship speed reaches 21 knots, one set of nozzles is replaced by another with larger orifices. The change-over takes five minutes.

Normandie. "How can I wangle an inside look at the France in action?" His reply: "You work on it. I'll work on it. It may arrange itself."

It did. Five days later I had flown to Paris, and been briefed by a director of the French Line. "You sail tomorrow," Captain Zanger said. "Now, these points: Some members of the press sentimentalize the France as the last of the golden galleons, sailing into the sunset of transoceanic surface travel. We disagree. In 1938, 668,000 passengers crossed the North Atlantic by ship. Last year there were 800,000, in spite of the airlines. So it would seem that many people are not captivated by Mach speeds.

"Second point: Do not embarrass yourself by claiming a revolutionary new design for the France. She is simply a spectacular evolutionary vessel—like your S.S. United States. *Bon voyage!*"

It didn't start so *bon*. I made the mistake of sliding down a stanchion onto the France's otherwise inaccessible bridge, just as the big girl cast off from Le Havre with a final blast of her horns—trumpets whose reverberations can be picked up nearly 100 miles away. I handed my letter of introduction to an officer, who disappeared into the chartroom. He returned, stern-faced. "Captain Ropars says you should not be here. He also says that since you are already here, and carry a sketch book, you may stay and execute a drawing."

Two-foot wheel on the bridge flips the France's 74-ton rudder, with a powerful assist from four electrically controlled hydraulic cylinders 900 feet aft. The officer on duty is watching one of two radarscopes for blips.

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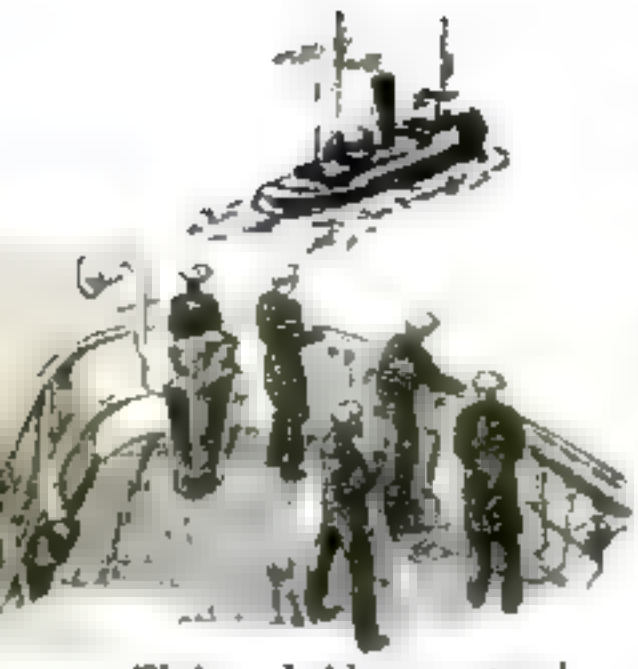
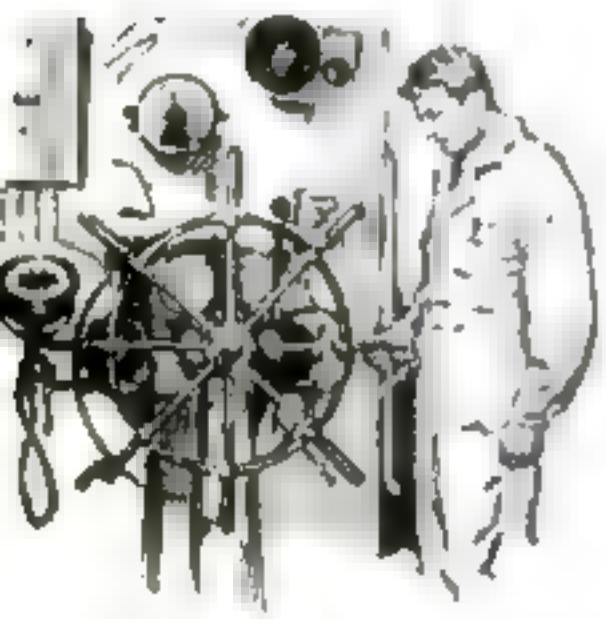


Flying bridges extend nearly 30 feet beyond both flanks of the France's hull. This unusually large overhang eliminates need for an auxiliary docking bridge near the stern.



For emergencies: This wheel that nobody wants to use, above and just ahead of rudder, would take over if control from bridge was lost in fire or collision. It works electrically.

A million yards of soot. Two hours later I was in the office of Chief Engineer George Bouey. He picked up a pencil and pad. "You have come to ask questions. I anticipate the first. You are curious about the strange shape of the France's stacks."

I admitted my surprise when I first saw the exhaust spuming from the tips of four enormous smoke deflectors.

Bouey made a quick diagram. "Here are the eight boilers of the France. To produce 160,000 horsepower, they do the work of 28 boilers on the former Normandie. Each hour they must deliver 720 tons of superheated steam. For this, 41 tons of fuel oil must be mixed with great amounts of preheated air and burned.

"The resulting gas is not pure. For example, there may be more than a ton of sulfur in 41 tons of oil. During burning, the sulfur is converted into sulfur trioxide. Should water be added, it would become sulfuric acid, which eats into boiler plates and flues like cancer. So the gas must be kept always above the dew point—or 307 degrees Fahrenheit.

"This solves the mechanical problem. But the gas is still irritating to passengers. So is the solid matter in the exhaust. On a test run, we have measured the soot. It comes to a million cubic yards in 24 hours."

The Chief Engineer made an arc with his pencil. "To keep that soot and the gases from settling on the decks, you would need absurdly high stacks. We avoid them by blowing the smoke upward from the boilers at a speed of more than a mile a minute. Then we send it whirling through baffles that throw the solids outward and away from the climbing gas. Ninety-five percent of the soot falls back through big pipes, from which it is flushed into the sea. The remaining five percent, together with the gas, next strikes curved bonnets near the tops of the stacks. If the wind is blowing from port or starboard, the bonnets tilt to eject the smoke from the tips of the deflectors facing the blast. Back sweeps the exhaust across these deflectors.

[*Continued on page 171*]

How the World's Biggest Liners Stack Up

	Gross Tons	Length	Beam	Decks	Propulsion	Horsepower	Speed (knots)	Crew	Passengers
QUEEN ELIZABETH	83,673	1,031	118	14	Steam turbine, quadruple screw	158,000	28+	1,277	2,233
QUEEN MARY	81,237	1,019½	118	12	Steam turbine, quadruple screw	158,000	28+	1,261	1,904
FRANCE	66,000	1,035	110	12	Steam turbine, quadruple screw	160,000	30+	1,044	2,044
UNITED STATES	51,987	990	101½	12	Steam turbine, quadruple screw	Not available	30+	1,050	1,930

The Other Fellow's Job

Frogman with a camera

Twenty-one years ago Bruce Mozert took his first underwater photos. As a staff photographer for *PIC* magazine, he was sent to Silver Springs, Fla., to shoot stills of a Tarzan movie from a glass-bottom boat. He has been an underwater photographer there ever since.

His work shows up in many places. He does TV movie clips and publicity and advertising stills. He's lost count of the magazines in which his photos have appeared.

Mozert prepared for his career by taking a photography course at Merton Institute in New York and studying high-speed photography at the University of Florida. He got his diving experience on the job.

He stresses the importance of having the best possible equipment. Among the developments he pioneered are molded-plastic housings for underwater cameras and a 110-volt underwater lighting system.

Mozert is 45, married, and the father of three. Top underwater photographers, he says, make up to $20,000 a year.

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He gets paid for fishing

For many men John Oney's job would be a dream come true. Oney spends much of his working time field-testing new fish lures. He's an experimental and design engineer for the Fred Arbogast Co., his job is to come up with new lures that appeal to fish as well as to fishermen

Oney is 39, married, and the father of three sons. His home is in Akron, Ohio. He studied wildlife management at Ohio State, and was formerly employed by the Georgia Game and Fish Commission and the Ohio Division of Wildlife

Final proof of the bait, he says, is in the catching. Testing his lures takes him to some of the world's best fishing waters. He has angled for pike in Canada, bass in Florida, and giant rainbow and brown trout in Argentina and Chile

All this and money, too. He makes about $8,000 a year

Assembly-line coordinator

Making sure that green wheels don't end up on a blue Chevrolet is one of the duties of 26-year-old Ford McCammon of Detroit.

Each car body comes down the assembly line with an IBM card affixed. McCammon checks this card against the corresponding card in his file to make sure the two match. The information on the cards is then broadcast to more than 30 teletype machines along the line so that the proper engine, trim, and other accessories arrive for each particular model.

In making his selection of bodies to send down the line, McCammon must remember, among other things, that every eighth job should be a Chevy II and that two station wagons shouldn't be scheduled in succession. If there is a material shortage on certain models, McCammon must know whether substitute parts can be used; if not, he has to temporarily sidetrack these bodies.

Should a car body get past his booth without the card being removed and the information broadcast, the entire plant might have to shut down.

A graduate of Ford Community College, McCammon has held this job for more than 2½ years. He has two children. His nonunion clerical job pays $2.67 an hour.

Questions

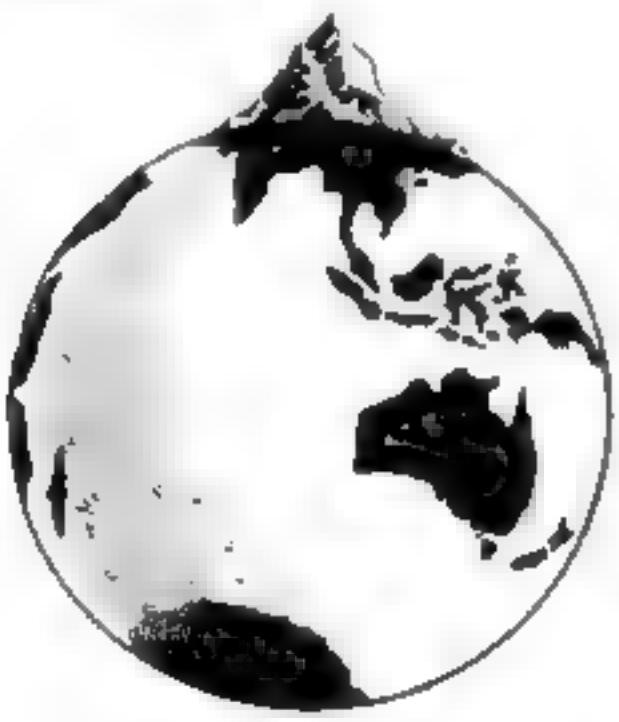
The race to space raises simple points that puzzle everyone—PS editors included. Here are answers to some of them

WE POLLED the POPULAR SCIENCE staff for "stupid" questions about space they had overheard from friends and neighbors (plus any they themselves had felt too embarrassed to ask out loud). "Stupid" questions shouldn't embarrass anyone—except the guy who has to answer them. For the simplest questions in science are always the most difficult. Anybody can rattle off details of thrust and orbits. It's when you're asked what *really* keeps a satellite up that you're in deep.

The most interesting of the questions follow, with equally simple (we hope) answers.

Why do satellites travel so fast?

That's what keeps them up. The simplest explanation is the original one, reasoned out by Sir Isaac Newton 300 years ago.



Sir Isaac imagined a mountain several hundred miles high with a gun mounted horizontally at the top. A bullet fired from the gun would eventually fall to the ground. But how far the bullet traveled before hitting the ground would depend on the muzzle velocity—the faster the bullet, the farther it would go. If the bullet were shot very fast, it would still fall toward the ground but it would travel so far it would always miss the earth. It would continue to fall around and around the earth: a satellite in orbit.

Why must it orbit so high?

Air resistance. If you could figure out a way to keep the atmosphere from slowing down a satellite, there's no theoretical reason why it couldn't circle the earth just high enough to miss the mountains.

Couldn't it orbit slower at low altitude?

No. The higher the orbit the slower

the satellite moves—Scott Carpenter circled the earth in 88 minutes, while the moon takes a whole month to go around. This decrease in orbital speed with altitude comes from the combination of two natural laws: 1) The force needed to hold a satellite in orbit increases with linear velocity squared, but decreases with distance; and 2) the force available (gravity) decreases with distance squared. When you put these facts together, it turns out that velocity decreases as the square root of the altitude increases.

How come many satellites have such eccentric orbits? Shouldn't they all be circular?

The speed and direction of the starting push set the path a satellite follows. Any elliptical path is possible. The satellite will keep going around so long as it doesn't run into the earth or move so fast that gravity can't pull it back. No satellite has yet been aimed precisely enough to get into a true circle, though a few have come close. And an eccentric orbit is often intentional. It sends the satellite far away, exploring thousands of miles of space, before gravity finally pulls it around and brings it speeding close to earth again.

Isn't the satellite free of gravity?

It's impossible to escape gravity completely, since the earth's attraction extends on and on indefinitely. The gravitational force does get weaker and weaker as you go farther and farther away from the earth.

Then how will space probes get free of the earth to reach Mars and Venus?

If the space ship starts out fast enough (about 25,000 m.p.h., the escape velocity) it will never fall back toward earth. Earth gravity will always be pulling on it to slow it down, but—because the pull decreases with distance—the slowing down will never be enough to overcome the outward speed.

If gravity is always acting, why is the astronaut weightless?

You feel weight only because something—the ground you stand on—resists the pull of gravity. When there is no resistance—when you are falling—you are weightless. The astronaut becomes weightless as soon as the rocket motors shut off. No force then resists the pull of gravity, he and his capsule are falling freely together, and everything is weightless. This is true for any kind of space trip: up and down, around the earth, to the moon, to the planets. He won't get weight back until some outside force—rocket power, air resistance, parachute tug—acts on him.

What happens if he falls out of the capsule in orbit, after accidentally opening the hatch?

He couldn't fall out. He and the capsule are falling freely together and they would stay together. If he pushed

himself out, however, he'd be in real trouble—the capsule would go one way and he would go the other.

Why do space rockets blast off so violently, subjecting the astronaut to rough G forces? Wouldn't a gentle acceleration, maintained for a long time, result in the same final speed?

Theoretically, yes. But today the only practical way to lift heavy loads into space is with short bursts of high

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acceleration—those are the only kinds of engines we have. Engines that produce light, prolonged acceleration—such as the ion engine now being developed—may take a ship from a space orbit to a planet, but lack the power to lift the ship from the ground to the orbit.

What do you mean "power to lift the ship from the ground?" Why is that so hard?

The 10-story-high assembly of engines and capsule that spun Scott Carpenter around the world weighed 133 tons at blastoff. This much weight had to be lifted against the force of gravity —just as you lift anything. Lifting such a tremendous weight so high takes a lot of foot-pounds of energy.

If it takes so much power just to lift a capsule into space, how can a little old ion engine push it the much farther distance to a planet?

The first few hundred miles are the hardest. The powerful chemical boosters will do most of the lifting (if they accelerate the capsule up to escape velocity, they will have done *all* the lifting). From there on, the capsule is like a feather in the breeze. A light touch will push it to high forward speeds.

How can they steer the rocket?

It moves in a direction opposite to the direction of engine exhaust. Turning the exhaust turns the rocket. Some engines swivel; others have deflection vanes in their nozzles. Or special steering rockets, mounted at angles, can be fired selectively.

Why do they always launch space rockets to the east?

They don't always, but it's easier that way. The earth rotates west to east. So a rocket just sitting on the pad already is speeding eastward through space at 1,000 m.p.h. (even as you and

I are right now). This part of the velocity needed for orbit or escape is free, it comes from the earth and does not have to be provided by the engines.

What do rockets thrust against once they're outside Earth's atmosphere?

They don't thrust against anything, inside or outside the atmosphere. They propel the capsule by reaction—"For every action there is an equal and opposite reaction." It's like the kick from a shotgun.

Why bother with extra engines to keep an orbiting capsule on an even keel? The astronaut, being weightless, would not feel the tumbling at all.

It helps in many ways but is most essential for coming back to earth. The capsule has to be lined up just right when the retrorockets are fired. Otherwise it might descend into the atmosphere backwards and burn up (the heat shield covers only one side), or land in the wrong place—or never land at all.

Why put the astronaut down over water where it takes a whole fleet to keep him from getting drowned?

The Russians have had good luck on land—but they control a lot of dry earth and very little wet ocean. The big advantage of a sea landing place is that it is a large, quite uniform area; you

know that the capsule will end up in the water, handy to ships. If you chose a continental terminal, the astronaut could come down in dry sand, a wet lake, a tree, or a rocky mountaintop; you couldn't be sure whether you'd need a jeep, a mule, an Alpinist, or a skindiver to extricate him.

How can so light and thin a heat shield keep temperatures inside the capsule bearable?

It's not that light and thin. It's ceramic that literally boils away. The boiling soaks up so much of the heat that very little remains to get through to the astronaut. The idea is basically the same as that used in the Arab's goatskin water bottle—evaporation of water through the goatskin keeps the remaining water cool.

How come the heat problem arises only on return to earth? Why not when the rocket is launched up through the atmosphere?

On the way up, the rocket travels slowest when the air is densest and gets up to top speed only when the air thins out. On the way down, the rocket ship is being steadily accelerated by gravity and travels very fast in dense air.

How can we keep in touch with space probes that go so far away —past Jupiter, for instance?

No sweat. Electromagnetic waves —light, radio, TV—easily travel very long distances through space. We already receive strong signals from small transmitters in very distant probes. Bigger transmitters will carry still farther. The only problem: the messages' travel time.

Then why do they lose radio contact with the capsule when it is very close to earth, coming in for a landing?

Air friction generates so much heat that the air molecules around the capsule are ionized—broken into electrically charged atoms. This blanket of ions is a radio shield. It creates an electric force that prevents radio signals from getting through. It acts just like the vast layers of ions in the upper atmosphere that affect short-wave radio communication between ground stations.

Okay, so we can send a man to the moon or a planet. But how are we going to get him back without all the complicated launching apparatus we have at Canaveral?

The moon-landing team will take with it everything needed for the return launch. Even for close-to-home orbital flights, a rocket cannot blast off until we are sure that a lot of different things will work at the right times: The boosters have to get the rocket off the ground, then other stages must "inject" the capsule into orbit; later, steering jets must operate; finally, "retrograde" rockets must fire to start the capsule falling back toward earth. The moon rocket will have all this plus a lot more—most important, a large rocket stage to be fired for the return launch.

Could we shoot down a foreign satellite?

'Tain't easy. We might, with a considerable effort, pin down its orbit after lengthy radar observation. Then we might launch one of our own satellites, guide it into the same orbit, and have it catch the intruder—to blow it up or push it away into space. ■ ■

And What Are *Your* Questions?

You have probably been stumped by simple space puzzles different from the ones in this article. Try them on us. (Postcards, please, addressed to Space Editor, POPULAR SCIENCE, 355 Lexington Ave., New York 17, N.Y.) We can't reply to each query individually, but we will try to answer the most interesting questions in a future issue of POPULAR SCIENCE

Before their hard drive, much of it through mountainous terrain, staff members Hubert Luckett,

1,000-mile test drive compares

T-Bird, Wildcat,

Three PS editors with different tastes try out three

HAVE you ever wondered what the results would be if three similar cars were driven in caravan on a long trip—same roads, weather, and speeds—with meticulous comparisons of fuel mileage and performance?

So have we at POPULAR SCIENCE. So we did it. We have the results for you.

The three cars: the Chrysler 300H, the Buick Wildcat, and the Ford Thunderbird. The 300H and T-Bird were convertibles, the Wildcat a two-door hardtop. These are "sports-type" cars, as distinct from true sports cars. All are expensive and powerful.

In the versions we drove, two of them were loaded with extras. The Thunderbird in particular was laden with all manner of options, including a trick deck lid that opened up at the push of a button to swallow the top. The Wildcat even included the luxury of air conditioning.

The drivers were Devon Francis, automobile editor; Martin Mann, science editor; and Hubert Luckett, technical editor. The trip: a fast loop from New York City through Quebec and Montreal and return—a total of 1,012 miles.

The results? Well, that takes some telling. The arithmetic of gas mileage and acceleration brought no arguments; on subjective judgments, a lot depended on who was driving which car at which time. (Drivers switched cars about every 100 miles.)

The terrain varied widely. In New England the two-lane roads selected were hill-and-dale, twisting through softly contoured, green-clad mountains. In Quebec, flat as a billiard table where the land sweeps toward the vast St. Lawrence valley, the roads were frequently

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On hard turns, T-Bird heeled most, 300H the least. Wildcat was almost as flat and surefooted as the 300H. T-Bird's specialty: a boulevard ride.

Devon Francis, and Martin Mann pause beside mounts—T-Bird, Buick Wildcat, Chrysler 300H.

and Chrysler's 300H

luxury hot rods—and come up with some surprising opinions

Overnight stop was made at Quebec's Chateau Frontenac. Canada's secondary roads—often narrow two-laners with unmarked right-angle turns, and crowned to boot—were a trial to cars as well as drivers.

Specifications on Cars Tested

	Chrysler 300H	Buick Wildcat	Thunder-b,rd
Retail price*	$5,461	$4,357	$6,141
Wheelbase (in.)	122	123	113.2
Length (in.)	215.3	214	205
Height (in.)	55.7	56.3	53.3
Width (in.)	79.4	78	76
Weight (lb.)	4,324	4,328	4,400
Turning diameter (ft.)	42.7	45 9	40.2
Steering ratio (:1)	19.2	19 9	20.3
Axle ratio (:1)	3.23	3 42	3.00
Tires	7 60x15	7.60x15	8 00x14
Fuel capacity (gal.)	23	20	20
Crankcase capacity (qt.)	5	5	6
Lube interval (mi.)	32,000	1,000	6,000
Oil change (mi.)	2,500	4,000	6,000
Radiator capacity (qt.)	17	18.5	20
Piston displacement (cu. in.)	413	401	390
Compression ratio (:1)	10	10.25	9.6
Carburation	Two 4-bbl.	4-bbl.	4-bbl.
Horsepower	380	325	340
Weight of car per hp. (lb.)	11.3	13.3	12.9
Torque (lb./ft.)	450	445	427

**Factory-suggested retail price, including federal excise tax, but no other taxes, freight or dealer handling charges.*

The T-Bird's dials were the most easily read.

The Wildcat's were marred by its idiot lights.

The Chrysler instruments caused annoyance.

frightful. Badly surfaced, they specialized in unbanked, unexpected 90-degree turns. In upstate New York were stretches of snarled mountain curves. In all, the cars were treated to only 180 miles of cream-puff superhighways.

The drivers varied, too. Martin Mann is a typical motorist: a good, rather fast driver, more interested in a car as transportation than as a mechanical plaything. "Lucky" Luckett is a six-foot-three version of POPULAR SCIENCE's fictional Gus Wilson: an expert mechanic as well as an engineer, a hard driver, a sharp-eyed critic. Devon Francis, a more cautious

 CONTINUED

Each of the drivers had a first

Francis was forgiving—he loves any horseless carriage

CHRYSLER 300H: For a Detroit convertible, this is the closest thing to a dyed-in-the-wool sports car that I've ever driven. It was sure-footed. It was fast. The front seating was superb, the rear seating just a bit skimpy. The ride was, true, a trifle harsh, but how can you get rough-road performance like the Chrysler's without stiff springs?

If I can complain a little, the instrument panel is hard to read in bright sunlight. I also thought the noise level was too high. But the visibility, especially for a convertible, was quite good.

The Thunderbird: This was plainly the showpiece of the three cars—something bought to be seen in. The Bird snubbed down well on braking. The ride was splendid on smooth roads. On rough roads, the car tended to pitch about somewhat, but what joker is going to take it into the wilderness? The instrumentation was splendid.

The seating was pretty good. Parking the Bird was a breeze due to its short wheelbase. The noise level was tolerable. The front headroom and legroom, the front cushion height and depth, and the entrance room were easily the best.

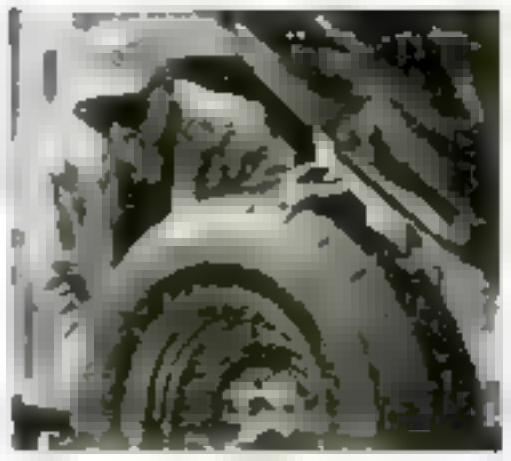
The Wildcat: You have to search to find its faults. Maybe the brakes do take hold a smidgen fast. Maybe it's not as easy to park as the other two cars. Maybe a carping critic wouldn't rate it A-1 on safety on account of all those control knobs.

But the Buick abounded in compensating virtues. It was almost apace of the Chrysler in handling. It took the hardest unbanked turns standing up. It responded to the accelerator lightning-fast. Its automatic transmission was by far the smoothest, its instrumentation the best.

Make a choice? Gosh! The Buick, I guess.

choice among $15,529 worth of automobiles

Mann asks comfort and convenience in the cars he drives



Luckett has an eagle eye for automotive machinery

THE plain fact is that I wouldn't buy any of these three gaudy chariots (even assuming I might blow that kind of dough on a vehicle, ha-ha). My car has to transport a family; these bombs are designed for two, with marginal accommodations for two more. Of them all, the Buick Wildcat is probably the best compromise. It's a wildcat, all right, taking off, zooming to pass, and running flat out. It's comfortable, convenient, and seems the roomiest of the three.

But I wouldn't want a compromise. A car bought for fun should be ostentatiously hot and flamboyant. The 300H is hot all right. It will negotiate wicked turns very solidly. And though the driver's seat is a marvel of comfort when you adjust it right —a nuisance without power assist—the ride is definitely hard on your bottom, and the back seats are for midgets

The T-Bird, while behind the other two in performance, still has more seat than I'd need. Its seasick wallowing on uneven pavement would concern me more if I thought it could be a family trait and not just an idiosyncrasy of the sample I drove. Otherwise it's fun: easy to drive, a sexy look, zany gadgets (like that power-operated deck lid) to delight small boys of all ages.

None of these cars would win any prizes for safe design. Dashes are padded and wheels recessed, but each had a "cookie cutter" in the center of the steering wheel, and interiors are full of sharp edges that stick out at the passengers from all directions.

If Fairy Godmother lined up all three and commanded, "Choose one!" I'd be drawn to the T-Bird. Those power-operated gadgets!

THUNDERBIRD: Least convenient to enter, and shy of legroom when you're in. Steering is numb, with little road sense; some shock fed through the steering column. A pillow-soft ride on good roads; on others there's continuous, lazy, vertical motion, like a boat in a swell. It leans heavily on hard turns, with tire squeal, and wallows on rough roads.

Acceleration is adequate but not spectacular. Same with brakes. Some fade sets in after three panic stops from 60. Minor luxuries abound.

Chrysler 300H: Easy entrance, with plenty of head- and leg-room, and a very comfortable driver's seat. Steering is fairly quick precise, with no road shock. The ride is moderately harsh on smooth surfaces but gets little worse on terrible roads. It corners flat, without tire talk or skittering. Acceleration is all you want.

Brakes are pretty good, though with some fade after the third hard stop. (But that low pedal could make trouble if you lost assist.) Instrumentation is complete —full gauges—but the cluster design is abominable. Turn-signal lever, on the dash, is clumsy.

Wildcat: Easy entrance to nicely contoured buckets, though the back is a bit erect. More legroom than I could use. Ride feels soft on good roads; you expect it to wallow when the going gets rough. Not so. It takes hard turns with little lean, no squeal, though with a little skitter on corrugations.

There's plenty of pep, the equal of the 300H in passing ranges. Brakes are excellent, with no fade in repeated crash stops. The instrument line-up is disappointing: a string of idiot lights.

Of the three I'd pick the Wildcat.

CONTINUED

chauffeur, is crazy about automobiles and has had a romance going with them since his Model T days.

How did the cars stack up?

On acceleration, the three cars compared this way:

	300H	Wildcat	T-Bird
0-60 m.p.h. (sec.)	7.7	8.7	9.8
40-70 m.p.h. (sec.)	6	6	8.2

On fuel mileage, measured for more than a thousand miles of hard driving, they compared this way:

300H	13.1 m.p.g. plus 1 qt. of oil.
Wildcat	12.3 m.p.g. plus 1 qt. of oil.
T Bird	13.3 m.p.g. (no oil needed).

For other comparisons, see the box of numerical values below, and the three driver-opinion reports.

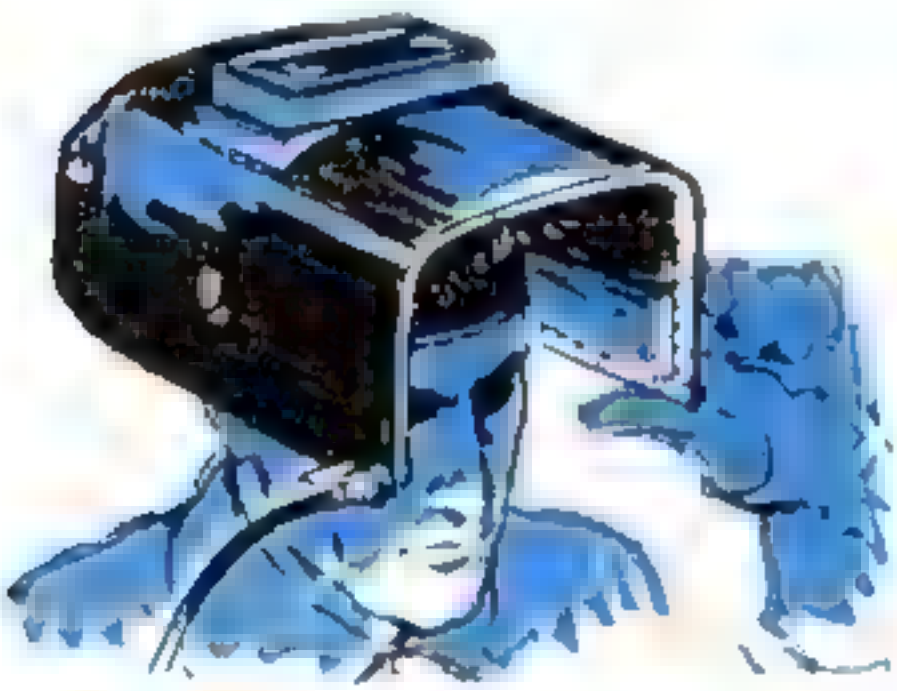
How the Cars Were Rated

Automobile Editor Devon Francis devised a point-rating system for the cars. In the table below are 15 items, each assigned a number of possible points, graded as to importance. Performance, for instance, is given 100, parking 25. The "price factor" is a judgment on dollar value. The Wildcat and Bird had numerous options. The 300H did not. Basic Wildcat price: $3,927. The Bird's: $4,321. Points awarded were averages among the three drivers. The maximum point rating for a car—unattainable, of course—is 1,000.

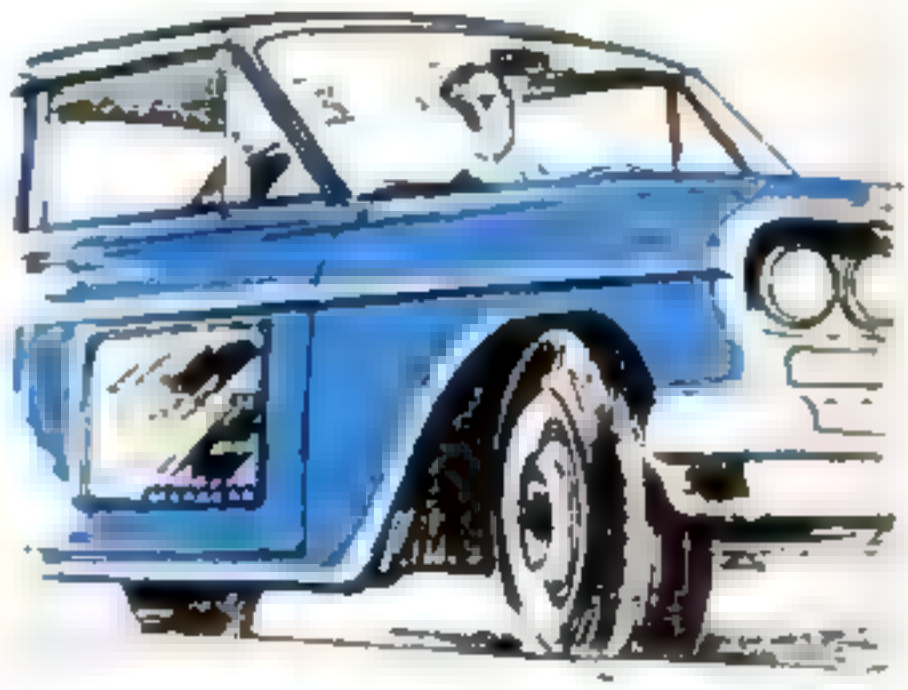
	Possible Points	Chrysler 300H	Buick Wildcat	Thunder-bird
Performance (based on 40-70 m.p.h. in seconds; no premium on top speed)	100	93	93	90
Brakes (based on straight line stop, effectiveness, fade, pedal effort)	100	83	80	83
Handling (based on feeling of security at high speed, predictability on turns, body lean, tire squeal, stability on rough roads, steering ease)	100	93	86	58
Economy (gas mileage, recommended oil and lube intervals, tune-up cost, crankcase and radiator capacity)	100	61	58	65
Safety of passenger packaging	100	66	66	68
Ride	75	55	66	60
Seating, interior roominess	75	66	63	53
Assembly, finishing details	75	61	66	61
Visibility	50	30	41	28
Convenience of controls and operation	25	12	19	15
Instrumentation (number, kind, visibility)	25	12	16	18
Ease of getting into and out of car	25	16	16	12
Ease of parking	25	13	12	16
Noise level	25	13	20	20
Price factor	100	61	65	55
TOTALS	1,000	735	767	702

"I'd like to see them make..."

Recessed toe holes built into sport-boat transoms. This would make it unnecessary to carry along boarding ladders for swimmers and water skiers.—*F. C. Tingle, State College, Miss.*

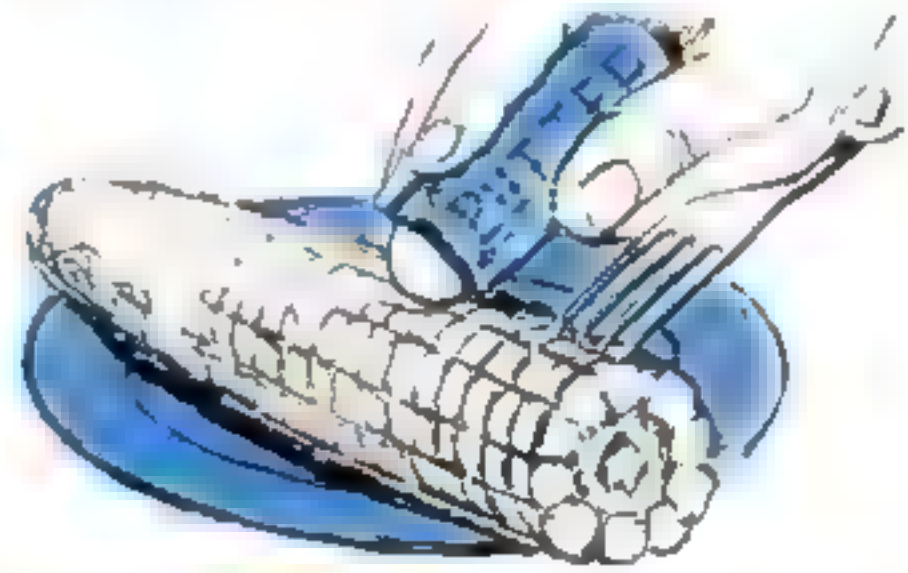


Air-cooled welding masks with plastic hose—perforated every inch or so—around the outer edge. You'd hook this up to a small air compressor.—*R. O. Kaley, W. Carrollton, Ohio.*



Curbside-view doors on automobiles. If the lower portion of the right-front door were made of transparent material, curb parking would be easy.—*J. L. Schauer, Norwich, Conn.*

Eyeglasses with air pockets in extra-large, bright-colored bows. Then boatmen and water skiers could fish them out if they dropped in the water.—*Barry McFarren, Cromwell, Ind.*



Butter in roll-on containers (like those used for deodorants). Packed with butter, when warmed they'd make preparing corn-on-the-cob simpler.—*Mrs. David R. Gund, Girard, Ohio.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's yours? We will pay $5 for each one published. Please use Government postcards only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 17. Write your name and address clearly. Contributions cannot be acknowledged or returned.

No Prop, No Rudder—

No Sweat

PS tests a jet boat on a 196-mile cruise on the Green and Colorado rivers—finds that it takes rocks, snags, and sand bars in stride

By Hubert Luckett

"I DIDN'T believe it until I tried it, but now I'm convinced. These things are *the* answer for these rivers." The words are Arnold Feller's, an expert boatman of long experience in building and racing boats on the rivers of the West. The "things" he was talking about were jet-drive boats.

I had come out from New York to test a jet for POPULAR SCIENCE on a 196-mile rough-water cruise down the Green River and up the Colorado from Green River, Utah, to Moab, in the same state. We wanted to test the boat under the toughest conditions we could find, rather than try it in

High speed in these waters demands first-rate visibility. I drove perched on seat back.

Backing off a sand bar—which I ran onto hard, deliberately—was easy with reversed jets.

The hull was designed for 30 m.p.h. with an outboard. We cruised easily at 35—could do 45.

View from driver's seat of test boat shows sister jet running ahead. Scenery like this made it tough to keep a sharp watch for hazards.

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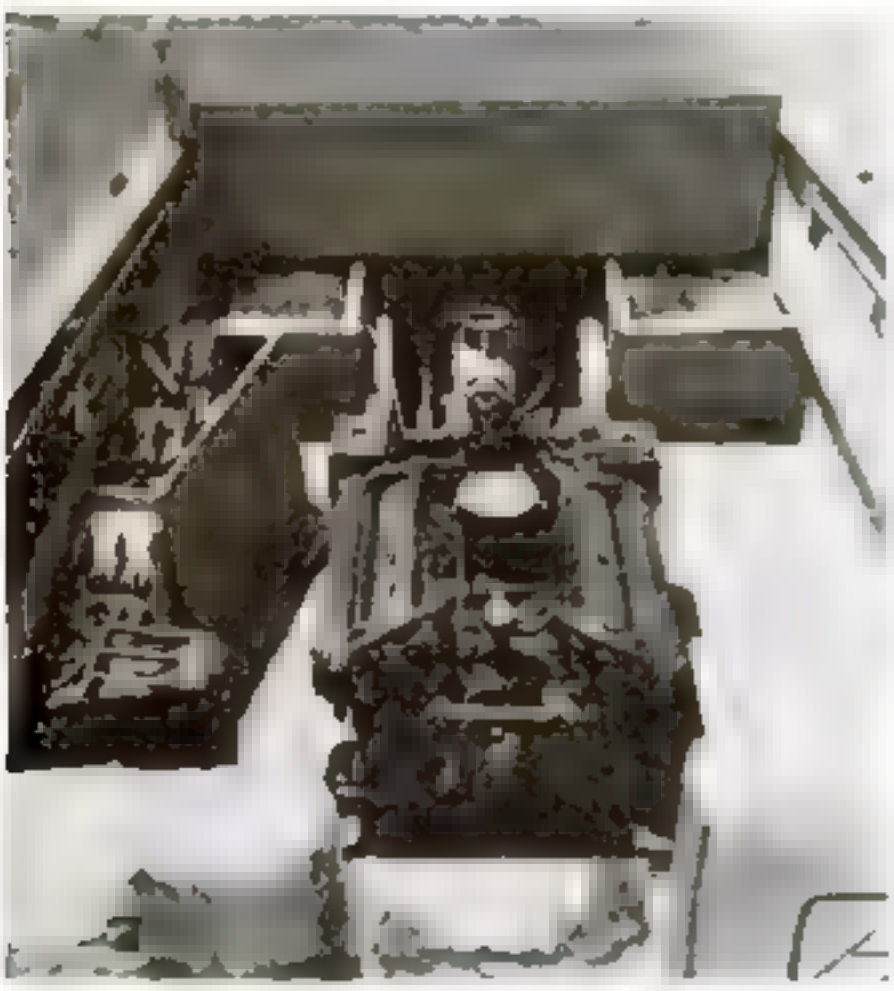
Inspection plate, sealed with rubber gasket and wingnuts, covers handhole in top of pump housing. If anything gets wedged in the impeller, it can be removed from inside the boat



No gears, no clutch, no cant

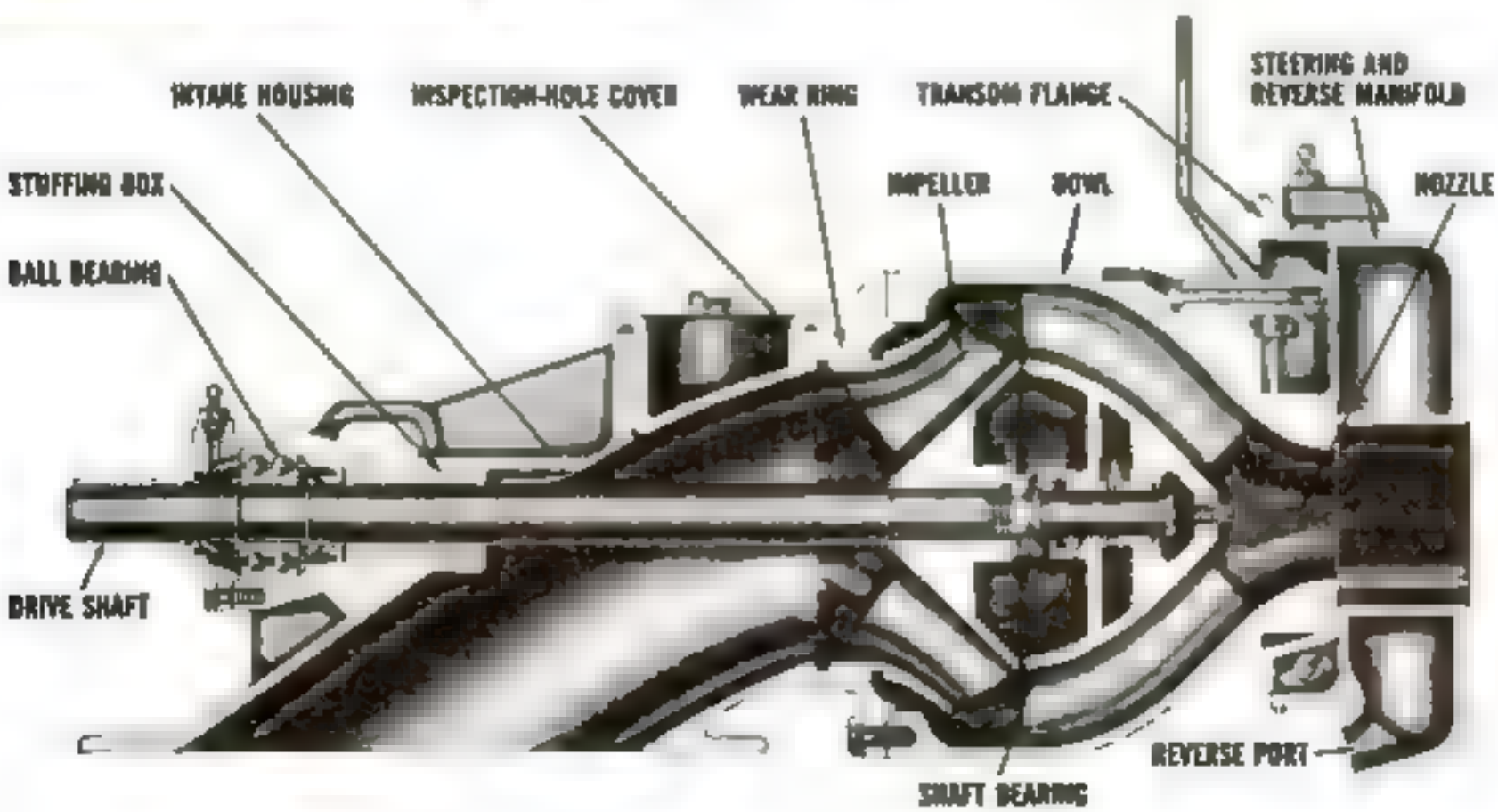
some sheltered bay or lake. We asked Feller to help because he knew the country and treacherous waterways as few men do.

Squirting water out a hole in the transom doesn't strike most people as a very efficient way to move a boat. But then a lot of hot propeller pilots scoffed at "oversize blowtorches" when jet aircraft first showed up.

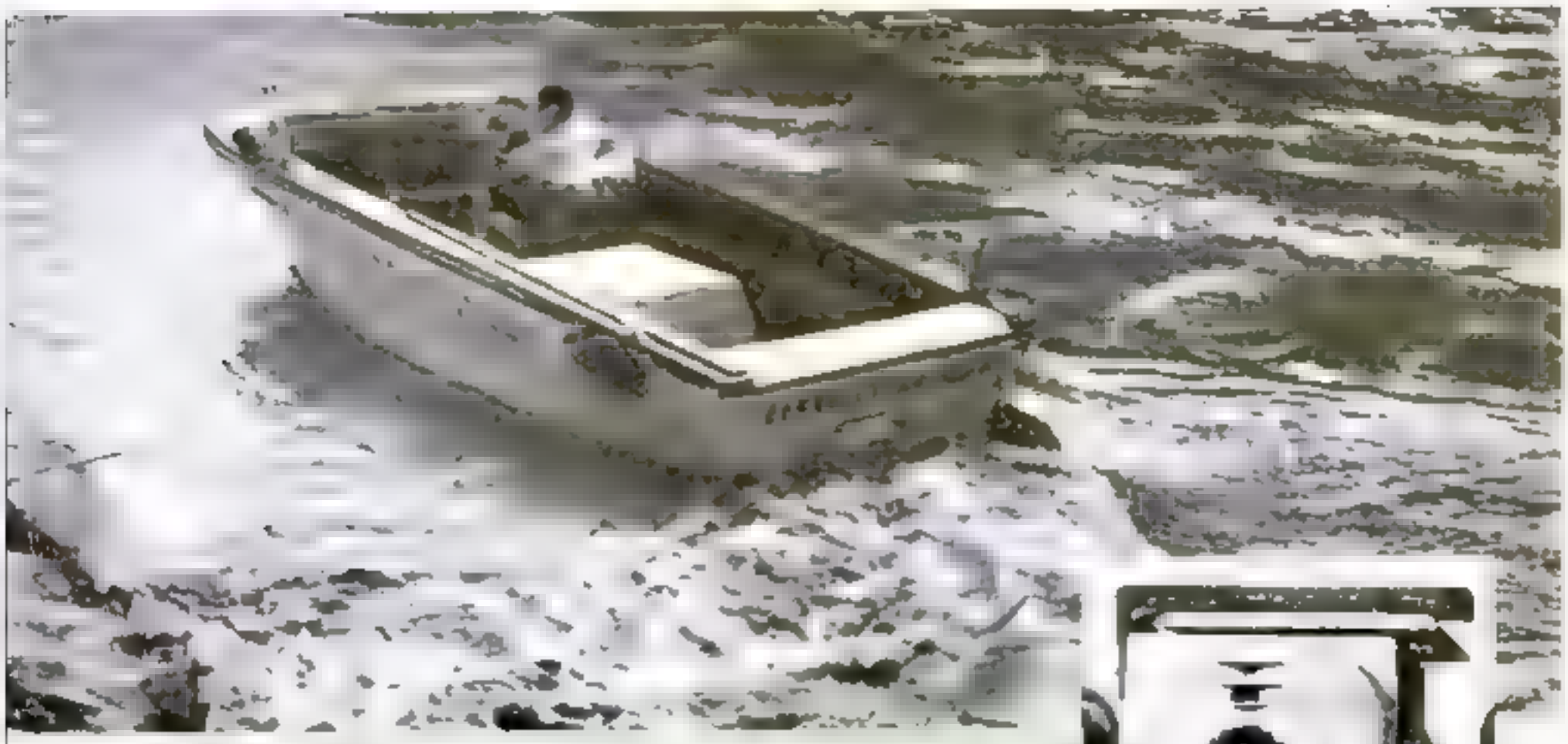
Jet planes and jet boats work on the same principle—you throw weight overboard in a direction opposite to the way you want to move. In a plane the discharged mass is hot gas; in a boat it is water.

A clean hull and reduced draft are the most obvious attractions of a jet-drive boat. With no propeller or rudder to hang up on sand bars or rocks, it can navigate waters unusable by ordinary power boats. But there are other advan-

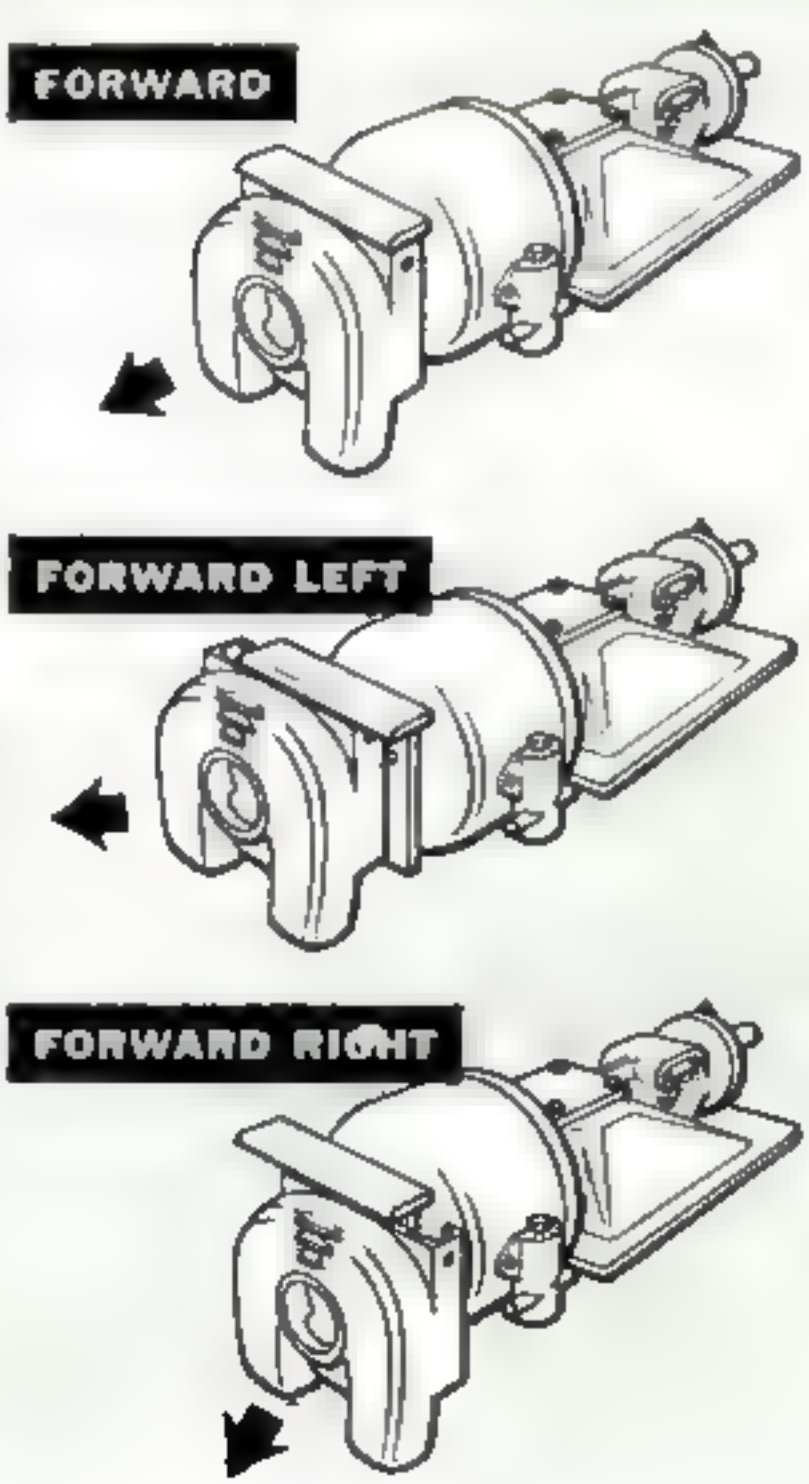
Crusader V-8 (a converted Chevrolet) is direct-coupled to a mixed-flow pump. Water enters a streamlined intake port flush with the hull bottom. In a mixed-flow pump, the vanes on the inlet side of the impeller are shaped something like a suction fan and curve smoothly into a shape producing radial flow toward the discharge side. But the flow, unlike that in a straight centrifugal pump, is at an angle of less than 90 degrees to the shaft.



—with a jet, you just hitch an engine straight to a pump



Steering deflector covers discharge nozzle and controls direction of thrust. Nozzle orifice is in a plate fastened to the transom. Deflector manifold makes watertight seal against plate, slides to various positions to direct stream as shown below. Photo above shows stream deflected to left when the manifold is positioned as in the inset at right.



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Arnold Feller, our guide, a race over course after cruise, made it in 4 hours, 19 minutes. He's a boatbuilder in Grand Junction, Colo

Start of the cruise: That's PS editor Bob Crossley and his wife. Life jackets are a must. Our companion jet is in the background.

End of the cruise: There's room on the loading ramp at Moab to handle eight boats at a time. Even so, we had to wait two hours for our turn

tages that promise a bright future for jets even where shallow water is no problem:

- The engine can be coupled directly to the pump—reverse gear or clutch aren't needed.
- The line of thrust is practically at the waterline, eliminating stern-squat caused by a prop pushing at the end of a lever arm under the boat.
- The engine can wind up to peak output as soon as the throttle is opened, giving quicker acceleration.
- Propulsion efficiency can equal or exceed present standard prop drives. And with continued development, the jets promise to give a substantial edge over props—particularly at higher boat speeds.
- Higher horsepower can be absorbed with relatively small impellers.
- Torque effects of external props are eliminated.
- It's steered by changing the line of thrust, as with outboards and outdrives, for better maneuverability than with conventional inboards.
- The quick getaway and the safety of a propless drive make jets especially suitable for water skiing.

On paper the jet looked good. But we wanted to see, firsthand, how suitable jet drive is for family boating.

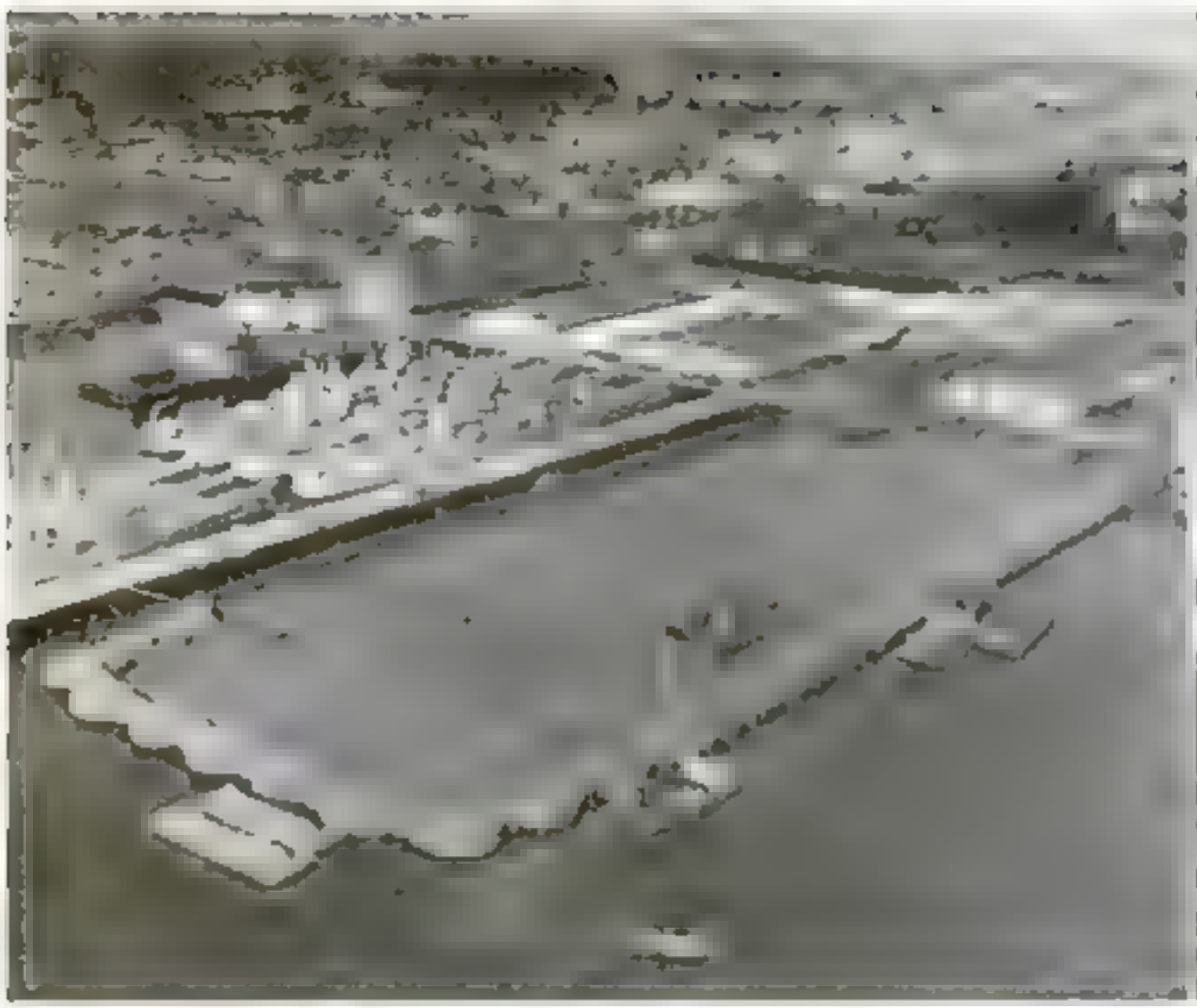
The annual Canyon Country Friendship Cruise in Utah seemed a fine chance for a thorough workout. So we arranged with the Berkeley Pump Co., manufacturers of the Berkeley Jet Drive unit, to supply us with a test boat for the trip.

This cruise runs through some of the most desolate, tortured, and wildly magnificent country in North America. This is the area Secretary of Interior Udall wants to make into a National Park.

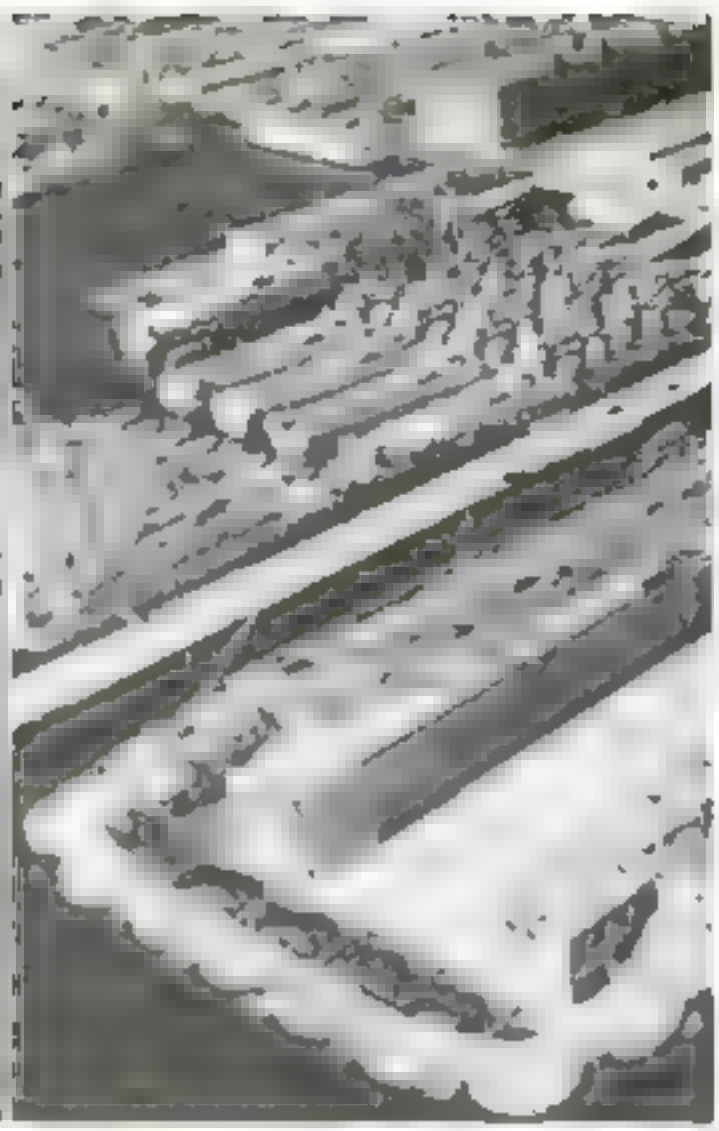
Starting at Green River, Utah, you go down the Green to its confluence with the Colorado, then up the Colorado to Moab. The trip offers plenty of sand bars, snags, submerged rocks, smooth water, swift water, and rough water. Of 762 boats on the cruise this year, 25 had

[Continued on page 174]

A small ranch at Anderson Bottom, reached only by boat, is the only habitation along the route.



February, 1960: With 11 steel cells, 60 feet in diameter, in place for seaward cofferdam pumping begins and dredging gets under way



October, 1961. Concrete work completed, next step is re-

New drydock is world's biggest

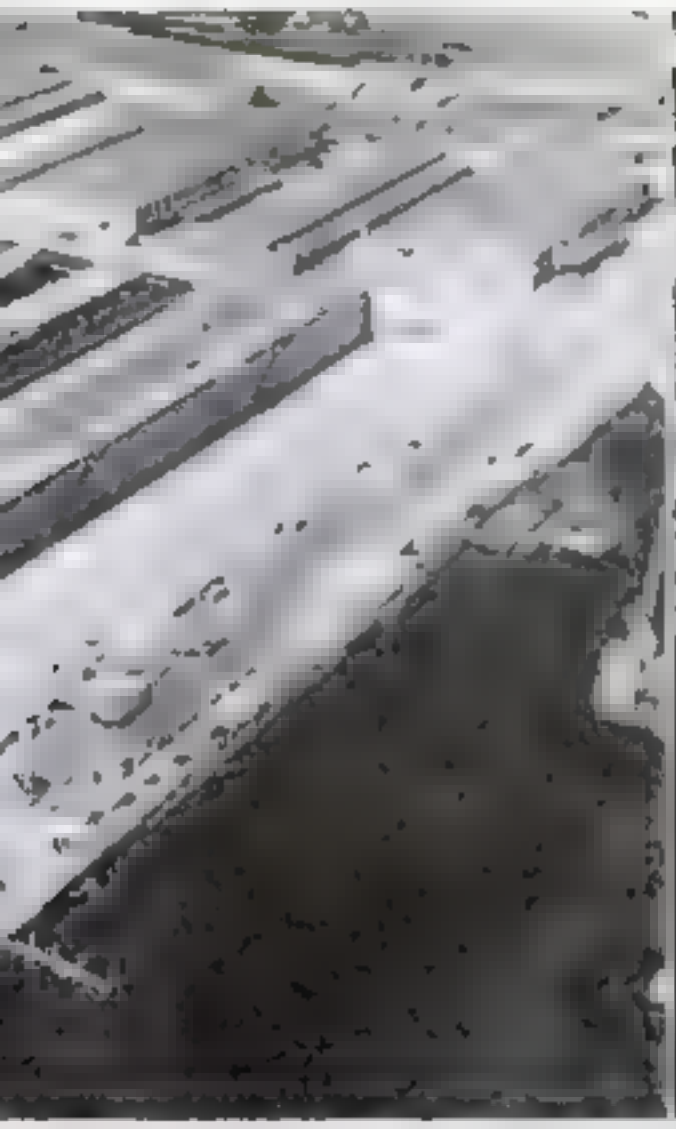
This giant basin recently completed by the Navy at its Puget Sound yards in Bremerton, Wash., was built outsize to handle future ships even bigger than our present supercarriers Forrestal, Enterprise, and Constellation. Existing drydocks are too small for these floating airfields.

The new berth gives them a comfortable

Bus-stop shelter is arched vinyl

Rigid vinyl panels have been curved to make this shelter at a bus stop in Morristown, N. J. Cables and turnbuckles hold them in place on an anchor at the base.

The panels are made by a European process at a new plant of Allied Chemical's Barrett Division at Edgewater, N. J. They will be used for siding, roofing, and on patios and carports.



moval of cofferdam cells for natural flooding of big tank

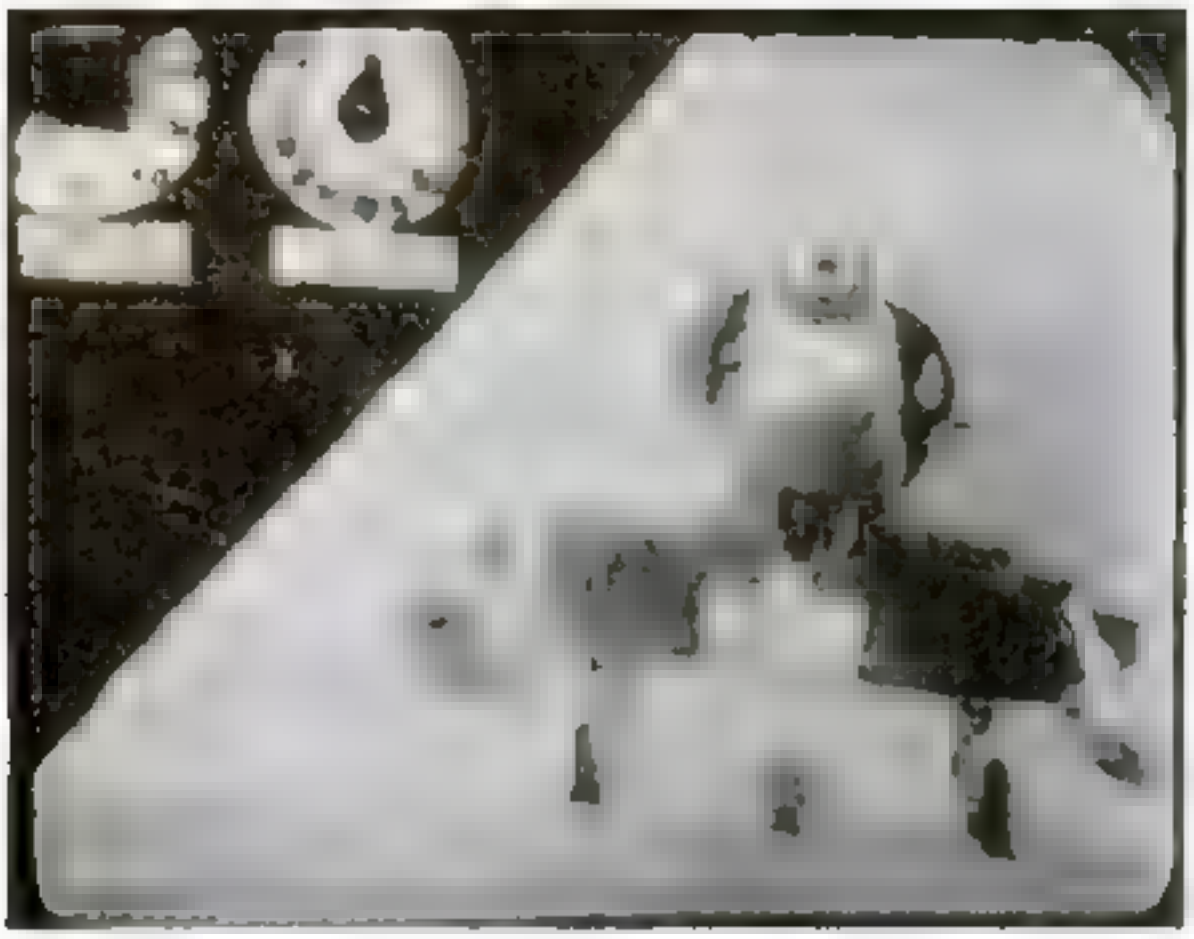
April, 1962 Last step to dock is carrier Kearsarge floating toward dock entry before pumping begins

margin. It is 1,180 feet long, 180 feet wide, 61 feet deep, and holds 80,000,000 gallons of water—enough to provide a bath for every man, woman, and child in Seattle across the Sound, with more than enough to spare for the breakfast dishes.

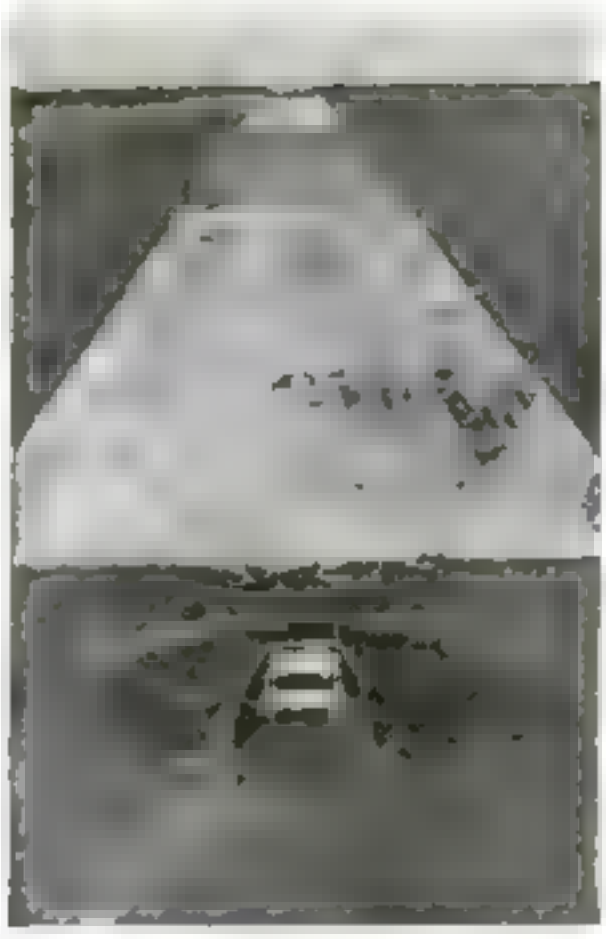
Big enough for three football fields or 33 basketball courts (with space for spec- tators), the huge tank can be flooded in 30 minutes. It takes nearly four hours to pump it dry. The job, begun in 1959, took 150,000 cubic yards of concrete, 5,300 tons of reinforcing steel, 5,440 tons of steel piling, 600,000 cubic yards of dredging, 1,300,000 cubic yards of fill, and 1,600,000 man-hours of labor. Cost: $23,000,000.

Long-reach sprinkler holds down dust on track between races

A 48-foot-long perforated boom mounted at the rear of a big tank truck keeps the track in shape for thoroughbreds at Aqueduct in New York's Queens. The long arm reaches almost from rail to rail to lay dust between races. A water wagon with a shorter reach follows in its wake to wet down dust in the area nearer the stands.



Touchdown of A4D Skyhawk taken by TV camera in flight deck (right) is shown on monitor screen in ready room. Date, radar, and wind readings are superimposed at upper left.



Camera is in light fixture protected by special cover plate from landing wheels of plane.

Closed-circuit television keeps eye on carrier landings

Three TV cameras tape-record aircraft landings on the carrier USS Coral Sea from approach to roll-out. One camera looks through a modified light well at the centerline of the flight deck. Stabilized against pitch and roll, it has a sensitive image orthicon tube for day or night televising, automatic sun shutter, and remotely operated iris that adjusts aperture for light changes. A second camera superimposes the date and radar and wind-velocity readings from the control-room data board. The third camera, on the carrier's island, follows each landing from the side as the plane passes over the deck camera, then zooms in for a close-up to record its identification markings.

Later study of the tape helps Navy pilots improve landing techniques.

Floating testbed for outboards

This big scow tests as many as 24 outboards at a time. Tethered on a 50-acre lake near the Perkins Group factory, in England, the vessel is propelled at random by the unbalanced churnings. The motors are run for eight hours daily, to test specific parts under rugged conditions; and for 500-hour endurance trials, equal to five years' normal service. The scow's gunwales are specially reinforced to take the motors' strain.

The Eager Beaver

Combining the skills of lumberjack, engineer, architect, and skindiver, he labors furiously to build his amazing dams

By George Laycock

EVEN the eagerest beaver sometimes tackles a job too big for him. Some months ago a beaver approached the big concrete McNary Dam across the Columbia River in Oregon. He took a quick look at the waters pouring through the navigation locks and set about correcting the trouble.

For a week the beaver frantically carried sticks and mud and tried to anchor them in place. But he could not hold back the brawling Columbia. Eventually he paddled off downstream, humbled.

Such defeats are rare. Long before men first thought of damming a stream, the beaver was doing it successfully.

This widely trapped animal, which had disappeared from much of North America by 1900, has staged a remarkable comeback. Through the efforts of wildlife conservationists and the creation of state game preserves, he has returned abundantly to large sections of his original range—in some areas to the point of becoming a nuisance.

When a beaver colony gets overcrowded the young leave home and follow the stream until they find mates and a suitable building site. Beavers usually build their dams close by a stand of aspen or poplar, the barks of which provide their favorite food.

As the sun sets, the homesteading beavers come out on the bank and begin

CONTINUED

Beaver dam measures about 15 feet across and three feet high. Many a human engineer has found that his best spot for a dam is one already chosen by his busy little competitor.

their timbering operations. Most of the trees they cut measure two to four inches in diameter, although beavers have brought down trees a yard thick at the base.

Nature has equipped the beaver well for this woodcutting. In the front of his mouth are two matching pairs of orange-colored teeth, 2½ inches long. They are self-sharpening; grinding against each other maintains a knifelike edge on the hard outer shell.

Because he can close his loose lips tightly behind these teeth, the beaver can even perform his wood chopping under water. Self-closing valves in his ears and nostrils further waterproof him. It's no trick for a beaver to stay under water six minutes before coming up for air.

The average full-grown beaver is three to four feet long and weighs from 40 to 70 pounds, although some 100-pounders have been recorded. Beavers ordinarily pair off until death. They live about 10 years. They mate in January or February. The litters, averaging three or four young, arrive in May or June.

Logging operations. To cut down a tree, the beaver stands full length on his hind legs and uses his broad 10-inch tail for a prop. He moves around the tree, cutting wood all the way and letting the chips fall where they will. He can bring down a willow tree four inches thick in five minutes. Can a beaver make a tree fall into the water when and where he wants it to, as some people say? Probably not. Once in a long while, in fact, an inept beaver drops a tree on himself, putting a premature end to his career.

A beaver cuts away at the tree until it begins to sway. Then he waddles off as quickly as his short legs permit and jumps into the water for safety.

He waits. If the noise of the falling tree attracts no enemy, he returns and speedily trims off the limbs and cuts them into convenient lengths.

He drags a limb to the water and, gripping it with his teeth, swims off with it trailing it over his shoulder. To move big logs, he swims alongside like a harbor tug easing a great liner into its berth.

The average beaver dam measures 15 feet across and 3 feet high. But some have become monumental. Perhaps the largest on record is a massive collection of sticks, stones, and mud stretched across the cold waters of the Upper Bow River in Saskatchewan. Including its wings, this dam measures 5,200 feet. It is 10 feet high and holds back 30 acres of water.

Choosing the site. The little engineer starts his dam in the deepest part of the creek, often where the water is a couple of feet deep. The first sticks are placed in the bottom of the creek parallel to the current. These, if the beaver can find them, are waterlogged branches from the water's edge. They're easier to hold

down than green sticks. The butt ends of the sticks face upstream and are anchored in place with mud and stones. The building goes on, stick by stick, until a mass of material begins to emerge above the water's surface, with the level of the creek rising gradually behind it

A beaver does all his work from the upper side of his dam. As long as he is in water his webbed rear feet are excellent propelling paddles and his broad tail makes a fine rudder.

He slides each new stick over the top of the dam and locks it in place. As the dam grows, night after night, he no longer takes care to place the sticks parallel to the stream's flow. It becomes a haphazard job. It may contain rocks of 10 pounds or more. But it holds water.

The upper surface of the dam is plastered with mud which the beaver carries in his front paws from the bottom of the pond. Time after time he dives to the bottom, and each new scoop of mud helps seal the dam and deepen the pond. (He does not, as some have said, use his tail as a trowel, or as a little barge for floating mud across the pond.) Gradually the pond spreads over three or four acres.

In creating a home for himself, the beaver also creates homes for many of his neighbors. Ducks come to nest. Trout, as one study in Maine shows, become more abundant. The kingfishers find things more to their liking and so do the redwing blackbirds, mink, skunk, muskrats, and turtles. Deer and moose come for the succulent water plants.

Seldom a night passes that the dam doesn't need some repair, patching, or enlarging. Should the structure spring a leak, the beaver quickly follows the current to the exact spot where the water is escaping.

Farmer's friend. This talent has come to the aid of more than one farmer whose irrigation dam was losing water. In one case a farmer, try as he might, couldn't locate the leak. But one night a pair of beavers moved into the lake and sealed his dam.

This everlasting drive to hold back all running water sometimes makes enemies for the beaver. Some months ago New Jersey fishery biologists opened the valve on a lake they wanted to lower. But only by sitting sleepless all night beside the valve were they able to keep beavers

CONTINUED

Typical floor plan of dome-shaped lodge (about five feet high and 12 feet wide at the surface of the water) includes: 1) feeding room, 2) toilet room; 3) sleeping room; and 4) nursery. Beaver enters by underwater tunnel (5). His feed pile (6) is conveniently close.

from plugging the valve as fast as it was opened. Damage complaints frequently come into conservation departments asking help against beavers that have flooded corn fields, killed trees, or caused creeks to submerge highways.

Why don't complaining citizens tear out the beaver dams? They do, if it's legal. They tear them out with axe and pitchfork, and blow them out with dynamite. But no sooner does night come than the beavers set to work frantically to repair the damage. One enterprising victim of the beaver built a straw man on top of the remnants of the dam he tore out. The next day the dam was repaired, and neatly worked into it was the framework of the scarecrow.

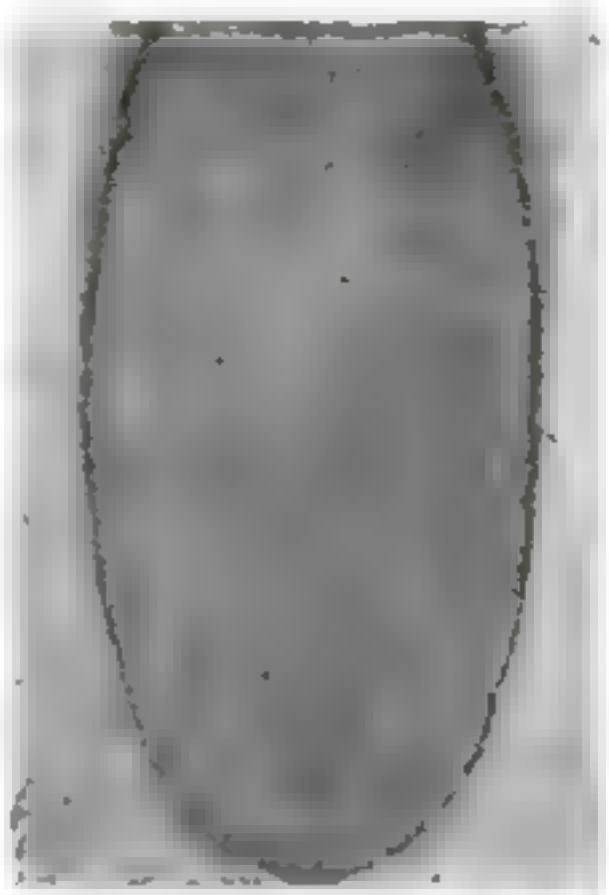
As a beaver dam grows higher, the tons of water behind it may threaten to push away the structure. Beavers have been known to build a second dam below the first. Water behind the second structure takes some of the pressure off the original dam and reduces chances that it will wash away.

Inland waterways. But human engineers with impressive college degrees look with even greater respect on the beaver's canals. Overland travel is difficult for the water-loving beaver. It is especially so when he is carrying a load of wood for food or building. But the beaver is up to this challenge, too. He builds a canal, about 2 feet wide, 10 inches deep, and sometimes several hundred feet long. Canals serve beavers just as they serve people; they make it easier for them to move materials.

By building his dam the beaver has created a refuge from his enemies. The water becomes a moat around his castle—a dome-shaped lodge at the water's surface.

The doors are under water. Should you surprise a beaver in open water he will smack the surface with his broad tail. Through a still woodland, the pistol-like crack can be heard half a mile away. Every beaver within hearing dives from sight, heading, chances are, straight for the underwater doors of his lodge.

At the outer edge the walls of the lodge may be five feet thick, a mass of sticks, stones, and mud. They're plastered from the outer side with a thick layer of mud that freezes solid during northern winters.



Broad 10-inch tail props him up when he cuts down trees.

But near the top of the house the wall is built thinner, and body heat from the beavers living inside melts the snow from the top of the structure. This "smoke hole" provides the beaver's home with ventilation. So with thick walls between him and his enemies, fresh air, a comfortable warm bed of wood chips, and a nearby food supply, the beaver may not come out in the open all winter long.

The full larder. The beaver has his busy, orderly life so completely planned that he doesn't have to go out of his pond for winter food. As winter approaches, he is busy cutting trees for future meals. He transports the limbs to the bottom of the pond near his lodge and anchors a great pile of them in the mud.

When hunger prompts him, he slides down his submerged hallway, selects a limb, and tows it back to the comfort of his lodge to strip and eat at leisure. He slides the peeled white wood back out into the pond. Later it will probably show up in his dam. The peeled limbs are easily spotted from the air.

How does the beaver know what depth to make his pond to keep it from freezing solid in winter? This is an unsolved secret. It is almost as mysterious as how the beaver knows, in the first place, all the techniques he uses so expertly in building his amazing dam. ■ ■

Facts and Fallacies About Your EYES

These "windows of the soul"—most precious of all our senses—are also the most intricate and least understood

By Lawrence Galton

HOW do you really see? Is your vision like everyone else's? Do glasses weaken or strengthen eyes? Is TV bad—or good for them? What about alcohol? Tobacco? What's the best way to use your eyes in driving?

Eighty-five percent of everything you learn, it's been estimated, comes to you through your eyes. And it's also been calculated that your sight regularly provides you—or should—with twice as much information about the outside world as all your other senses combined.

But it's one of the trickiest—and most misunderstood—of the senses.

Here's a rundown on what scientists now know about it—facts to take the place of many common fallacies.

Do you actually see with your eyes?

Your brain does the real seeing; your eyes are light-transmitting machines.

CONTINUED

Each of us has his own individual view of the world

In middle age, you may have to hold a paper at arm's length. The answer? Glasses.

Alcohol relaxes eyes' coordinating muscles. Working separately, they see two images.

What happens is this: Light rays strike an object—say, a girl—and are reflected to your eyes. They pass through the cornea (the clear front window), the aqueous (watery liquid behind the cornea), the pupil (opening in the colored iris), and the lens. The lens bends the rays and focuses them on the eye's rear inner lining, the retina, which contains light-sensitive pigments. When the rays impinge on the pigments, chemical reactions take place that send impulses through the optic nerve to the brain. Actually, the image is received upside down because the lens has inverted it, but the brain straightens it out and interprets it.

Are there different kinds of vision?

Surprisingly few people realize it, but there are.

Central vision—what you use when you look straight at an object—is sharpest. But you also have side, or peripheral, vision—and, though it's not very acute, it's important; without it, you would bump into things and be unaware of objects approaching from the side.

Here's a simple experiment that will demonstrate your side vision: With both eyes open, hold your right thumbnail 16 inches in front of your face. Have somebody hold a wrist watch at arm's length off to your left and gradually move it inward toward your thumb. Without moving your eyes, you'll be able to identify the watch as a watch probably when it's about 15 inches away from the thumb. Chances are you won't be able to tell time, though, until it's about two inches away.

Is your seeing different from other people's?

Each of us has his own individual view of the world. That's because, for one thing, the eyes can transmit millions of impulses per second but the brain chooses details—on the basis of our particular past experience, and mood and interests at the moment.

How we see things can also be affected by their meaning for us. In one experiment, when subjects had to estimate the size of coins and cardboard disks that were exactly the same size, they guessed, on the average, that money was one-fourth larger. The harder up financially a subject was, the more he overestimated the coin size.

Do men and women see differently?

At least in one sense: What's an eye-opener for one isn't necessarily for the other. The pupil of the eye—an opening like a camera's aperture—widens at night and in dim light, narrows in bright. It may widen, too, when you see something of special interest, day or night.

Eye strain may produce discomfort but will not damage the eyes themselves.

Side vision is not as sharp as central vision—but is quick to note movement.

Recently, University of Chicago investigators rigged up a device to measure changes in pupil size—and had two women and four men look at pictures of a baby, a mother and baby, a partially nude male, and a partially nude female. Not surprisingly, they found that the men's pupils opened widest when they looked at the female. As for the women their pupils opened most at the picture of the woman and child—and more at the seminude male than the female.

Do your eyes serve any purpose beyond seeing?

You may have noticed that a cigarette somehow doesn't seem as enjoyable in the dark. Vision's marked effect on taste has been shown recently in studies at a U. S. Air Force medical laboratory where volunteers were fed in a completely darkened room. Unable to see the food they could detect no difference in taste between white and whole-wheat bread, or between different canned fruits.

What eye traits are inherited?

There are more than 100—from minor imperfections to total blindness. Some families have long histories of nearsightedness, farsightedness, or crosseyedness. One family Bible shows that between the years 1637 and 1907, 135 out of 2,116 members couldn't see at night or in dim light.

Some inherited traits such as eyelid drooping are dominant—passed on from generation to generation. Others are recessive—skipping generations and reappearing when both parents happen to carry the same hereditary factors. This is why some brown-eyed couples, for example, have blue-eyed children, or green- or gray-eyed ones.

What causes nearsightedness? Farsightedness? Astigmatism?

All involve structural defects. The lens of the normal eye changes shape, flattening when you look at distant objects, thickening for near vision. This is called accommodation.

But if your eyeball happens to be too long from front to back, you'll be nearsighted, or myopic. The lens will be too far from the retina and, despite accommodation, light rays reflected from distant objects will be focused so they fall in front of the retina, producing a blur.

Farsightedness, or hyperopia, results when the eyeball is too short. Light rays from far-off objects will fall where they should, but those from nearby objects will hit the retina before they come to a sharp focus.

The surface of the cornea should be a perfect sphere, but frequently people are born with an irregularity in the curvature that causes distortion of images. This is astigmatism.

CONTINUED

All three conditions can be offset through glasses. These change the point of focus of the eye's lens system or make up for an irregular curvature.

Incidentally, eye defects may not always be handicaps. Three famed artists —Holbein, Cranach, and El Greco—developed their distinctive styles, a recent medical study claims, because they had severe astigmatism. Holbein saw objects distended laterally; Cranach saw them thinner than they were. El Greco's vision made people lean to the right. If the three men had lived in the present time, the medical investigator says, "they undoubtedly would have been fitted with corrective lenses in childhood—and would never have produced their strange and highly individual masterpieces."

How does vision change with age?

Most babies are born farsighted; their eyeballs are only two-thirds as long as they will be later. Usually, by the time a child is eight or ten, the eyeball length has increased sufficiently so the farsightedness is gone. On the other hand, some youngsters have longer eyeballs to begin with, or their length increases more—and they become nearsighted.

While the farsighted tend to become less so, the nearsighted tend to become more so—up to about the age of 20 when vision tends to stabilize.

By the age of 50, and sometimes sooner, many people need glasses for reading. The trouble—presbyopia—lies in the lens of the eye. With age, it gradually hardens and becomes less flexible, bulging less so close-up vision suffers. At early ages, objects as close as 2¼ inches can be seen clearly. In middle age, you may have to hold a newspaper at arm's length.

The answer for presbyopia, of course, is glasses.

What causes crossed eyes?

The eyes are turned by muscles, somewhat as reins turn the head of a horse. Improper balance of the muscles can make one eye turn inward, producing crossing—or outward, producing wall-eyes. Some times an eye may turn upward.

Contrary to popular belief, crossed eyes are not outgrown. And, because the crossing causes double vision, the brain may suppress the sight in one eye.

Glasses, exercises, and sometimes surgery can correct eye crossing and, if used early, can prevent vision loss.

Do eyeglasses weaken the eyes?

No. One reason for the common misconception is that nearsightedness tends to increase as a child grows older—and it's easy to jump to the conclusion that glasses produced the increase.

There's no scientific evidence whatever that glasses weaken the eyes—or that they strengthen them. All they do is provide clear and comfortable vision.

Does eye strain permanently hurt the eyes?

No. Strain—from overuse of the eyes or from defects in focusing power—can make the eyes ache and feel uncomfortable. It has been blamed for headaches, general fatigue, even abdominal cramps and dizziness—although many doctors now doubt that such symptoms really are due to eye strain.

But, as Dr. Morris Kaplan of the University of Colorado emphasized in a recent report to the American Medical Association, whatever discomfort eye strain may produce, it will not hurt the eyes themselves or damage sight.

Can you "save" your eyes by using them as little as possible?

Nonsense, says Dr. Kaplan. "Eyes, like fingers, arms, hands, feet, legs, brains, and lungs are to be used—and lack of usage may do much greater harm than usage. Of all the diseases the human eye is heir to, none can conceivably be made worse by using the eyes."

Is television harmful to the eyes?

Contrary to a lot of original foreboding, studies have shown no difference in the incidence of nearsightedness, far-

[Continued on page 162]

Bucket of wet concrete is lowered to workman waiting to dump it at form for pier footing.

Bucket empty, helicopter whirls back to pick up a replacement being refilled from the mixer.

Fast job of concrete pouring—by helicopter

This is the story of how a helicopter saved the lives of 15,000,000 baby trees:

The U. S. Forest Service wanted a number of concrete piers in a hurry in the Boise National Forest in Idaho. The piers were to carry a 15-inch water line from Lucky Peak Reservoir near Boise to a seedling nursery. They had to be built to minimum pool depth, and fast—while the reservoir's water was low. There was no road beyond the bluff at the reservoir's edge

Aggregate, sand, cement, and water were mixed on the road. Then a Bell 47G copter went into action, carrying canvas bags of concrete in relays from mixer to pier sites. As each full bag was delivered for use, the chopper swapped it for an empty, then returned to repeat the process. Trips took two to four minutes each way. A total of 60 5 cubic yards was poured in 18 pier forms

The cost: $60 a yard—about four times that of the concrete itself—but it was worth it. The project was completed in time to get water to the seedlings before the summer drought set in.

Fishing rod is wired for sound

The fisherman who has everything else can now listen to his favorite radio program while casting his line. A battery-operated radio has been built into the handle of a rod by John Frances, Weirton, W. Va. The rod itself is the antenna. The sound won't scare the fish; the radio is connected to earphones. The idea, says the inventor, is to keep the fisherman in touch with latest weather reports while far out on a Lake.

Jet stream parallel to waterline propels boat, with no moving parts under water to tangle in weeds.

Now there's an outboard jet

Once inboard jet engines proved practical on private boats, an outboard jet was bound to follow. Here it is. It works on the same principle as the inboard, getting propulsion from a jet stream shot out behind—like holding onto a fire-hose nozzle with the water turned on full force.

There's one major difference between inboard and outboard jets. The inboard jet tube is through the boat's transom; the outboard is detached from the hull. You need no rudder or baffle to make a turn. Just swing the tiller, and you can turn at full speed—in the boat's own length if you're brave enough to swing sharply. Full reverse is possible if the jet spout is snapped around a fast 180 degrees.

Power comes from an ordinary 5½-hp., two-cycle outboard motor that drives a pump instead of a propeller. Tested against a conventional prop-driven outboard of the same horsepower—same boat, same driver—the jet made the course in 26⅘ seconds, the conventional outboard in 35.

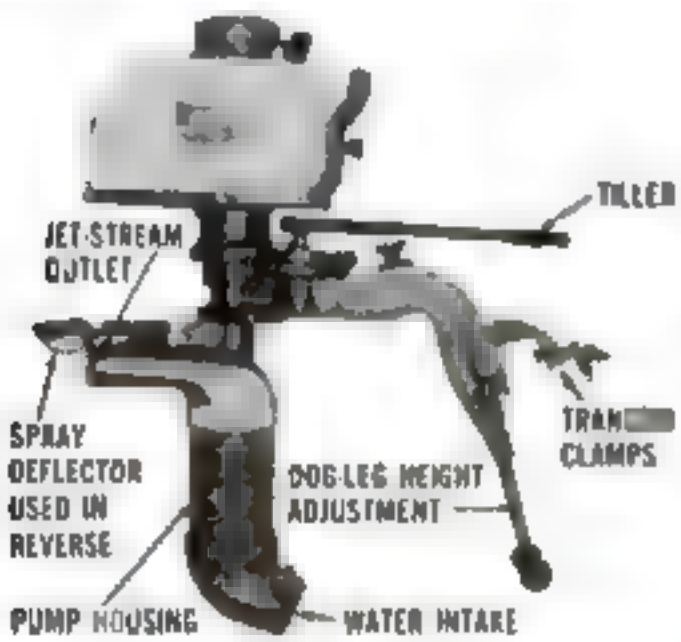
Outboard Jet, Indianapolis, sells the 5½-hp. jet for around $250. It plans bigger engines, has an inboard-outboard on the drawing boards with still more power.

Battery-powered fluorescent lamp

The telephone repairman at left is getting emergency light from a brand-new flashlight that uses a fluorescent tube instead of a bulb. Its plastic case houses a 15-watt, 18-inch tube; ordinary flashlight batteries; and a high-frequency inverter that converts battery current to the alternating current required to light the tube.

International Telephone and Telegraph developed the fluorescent flashlight for use also in boating, camping, trailers, aircraft maintenance, and mining operations.

No rudder; jet swings for turns.

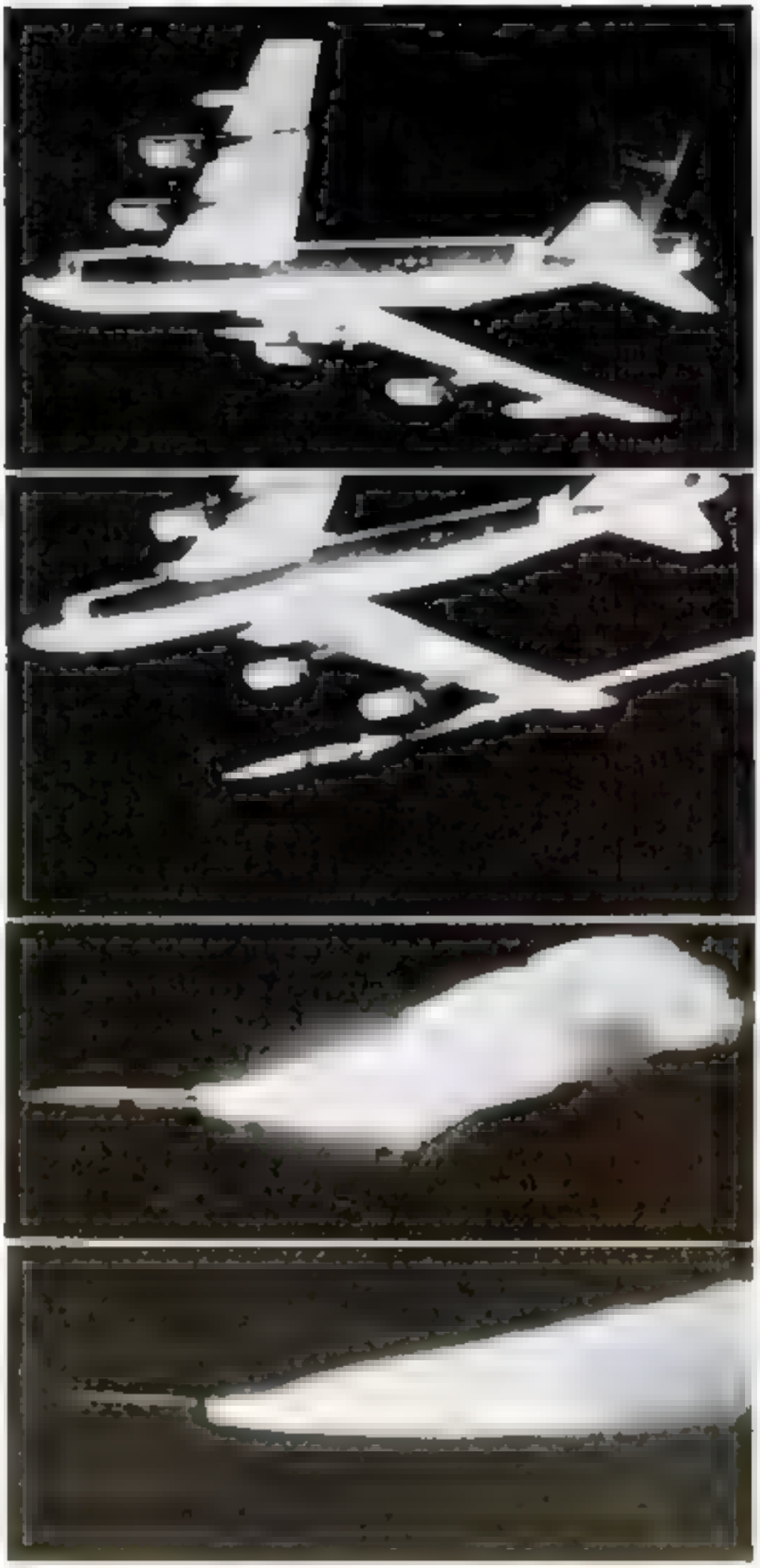


New jet looks like outboard with gooseneck pipe instead of prop

Music while she cooks

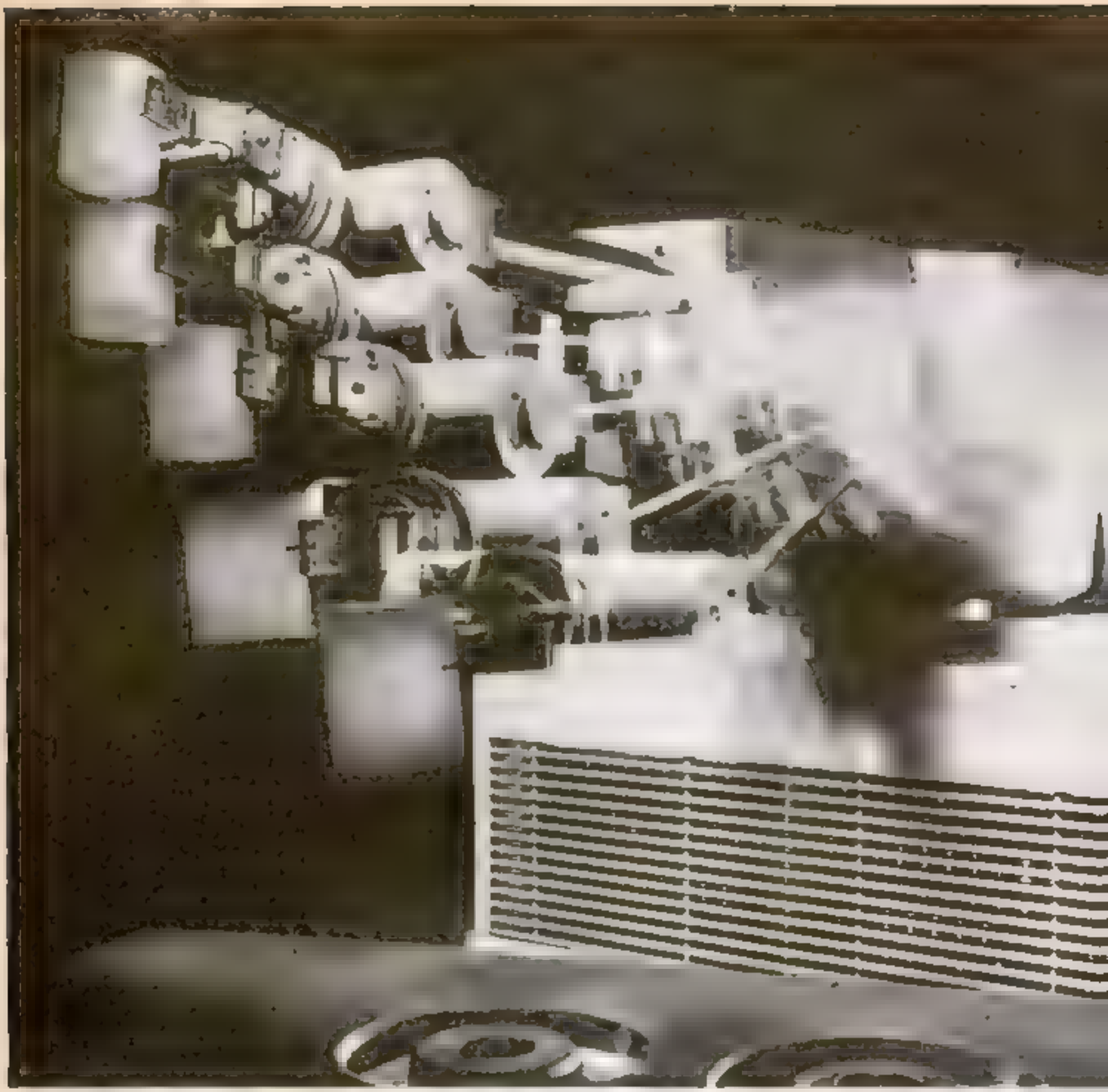
This British electric stove has a built-in seven-transistor radio for entertainment while meals are prepared.

The two-band set, with whip aerial, is installed in the range's control panel. Speaker is concealed by the splash back. The radio is insulated against heat and moisture. It's powered through a transformer from the stove's electric-line supply.



Ballistic missile launched from aircraft

America's first airborne ballistic missile has passed its initial launching test. The hypersonic Douglas Skybolt, carried under the wing of a B-52G jet bomber, was dropped high above the ocean off Cape Canaveral, Fla. It ignited successfully, then pitched upward on its ballistic course down the Atlantic Missile Range. The nuclear weapon, scheduled to become operational in 1964, has a range of about 1,000 miles. Air Force B-52s will be armed with four, British Vulcans with two each.



Unimate handles a red-hot billet. Multiple-exposure photo shows movement of turret-mounted

A robot takes a coffee break. Demonstrating its versatility, Unimate grasps coffee pot (1) and fills

hand carrying the load.

New Factory Worker:

Teachable Robot Can Remember 200 Commands

By Alden P. Armagnac

IT LOOKS like the gun turret of a tank, atop an oblong box. It comes to life with the loud whirring of a husky 10-hp. motor and a hydraulic pump. The turret swings, a tubular arm reaches out—and a steel hand opens and closes like a human one.

This new mechanical wonder is the first all-purpose robot for industry. To teach it a job, you simply lead it through its paces by the hand. Automatically it will perform the same task, over and over, as many times as you want. Then it will quickly learn to do an entirely different job.

If you want it to, this versatile automaton will play "My Country 'Tis of Thee" on a piano or xylophone. It will pour coffee, into cups set at random on a table—as it's pictured doing below. Or it will pick up alphabet blocks and spell its own name: "Unimate."

Actually the $23,000 robot will earn its keep, in industrial plants, at far more practical tasks. Automatically, Unimate will assemble parts, feed a lathe, tend a die-casting machine, operate a welding gun, spray paint, run a punch press, or load a conveyor.

From a die-casting machine, for example, its mechanical hand plucks a 500-degree-hot metal frame for the triangular vent window of a car's front door. The robot arm swings,

three cups set around table (2, 3, 4) without spilling a drop, after being taught where cups are.

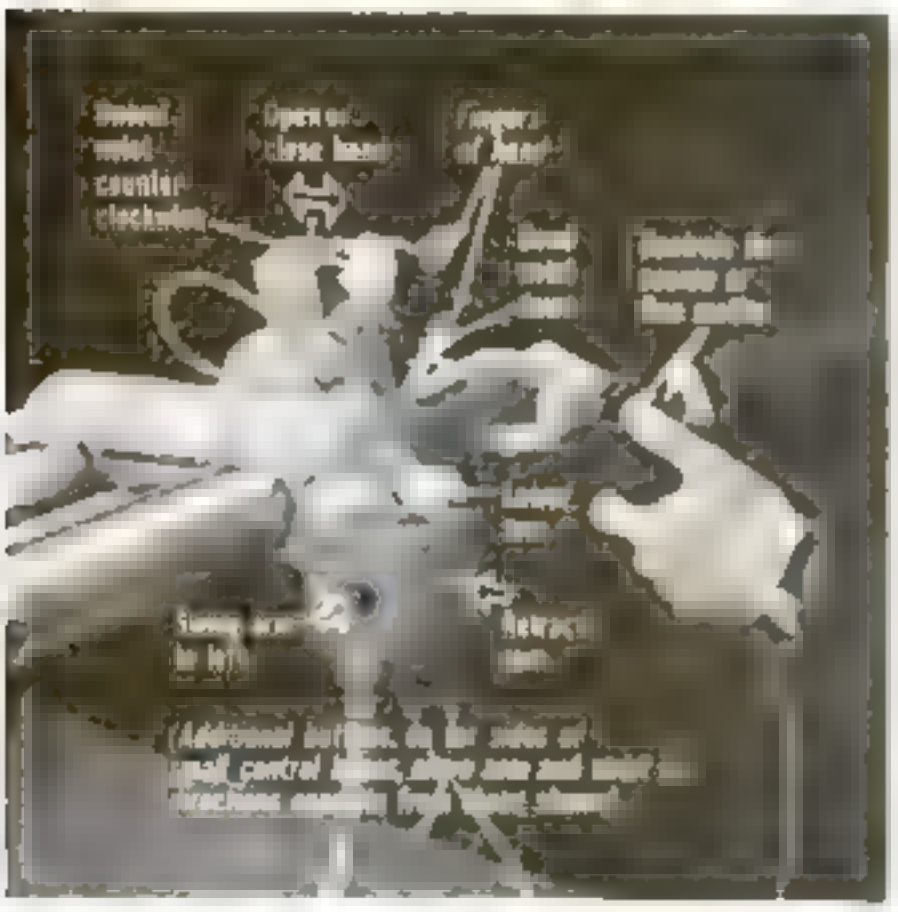
CONTINUED

dips, and plunges the frame into a quenching tank. Four seconds pass. Then the hand deftly lifts out the cooled frame—and drops it on a conveyor belt. The arm swings back to the die-casting machine, waits until another frame is ready—and the sequence repeats.

At the Bethel, Conn., plant of Consolidated Controls Corp.—Unimate's maker—this feat was demonstrated for POPULAR SCIENCE by the latest of the commercial-model robots to be built. The first one recently began doing a similar job for one of the country's leading auto firms, which is keeping its trials of the robot a trade secret.

Recording mechanical motions and playing them back is an art that has come a long way from the punched paper rolls of yesterday's player pianos and the pattern-forming perforated cards of early Jacquard textile looms. To modern factories, automation already has brought machine tools that perform intricate tasks, without human guidance, by following instructions recorded on magnetic tape or punched plastic. Until now, though, each of these elaborate and costly tools has been designed specifically for one particular kind of job.

Jack-of-all-trades robot. Unimate's a new departure. With it, a user can afford to automate an operation that will last only a few weeks before a production run is completed. Then a fork-lift truck will pick up the 3,000-pound robot and trundle it to another part of his factory, where it can be retrained—in 30 minutes or so—to tackle a new job. Hence its name, which stands for "universal automation."



Led by hand this way, Unimate learns a task. By pushing buttons of harness attached to robot, teacher puts it through desired motions. Unimate will repeat motions automatically.

Unimate's business end, its mechanical hand, grasps an object with two opposed metal fingers. They close under compressed-air pressure—which can be adjusted so they'll pick up an egg without breaking it or grip a steel block with 300-pound force. Interchangeable fingers of different shapes, some padded, fit whatever Unimate is to hold. It manipulates a 25-pound load with ease; one of 75 pounds at reduced speed.

A hydraulic-muscled arm and wrist wield the hand with the dexterity of a human worker—and a much longer reach. The extensible arm slides out from four to 7½ feet. It swings horizontally, on Unimate's rotating turret, through 220 degrees; and tilts up or down, to 30 degrees above or below horizontal. The wrist bends up or down through 220 degrees and swivels in a half-circle—enough to turn a piece upside down.

These five motions enable Unimate to grasp an object in any position, anywhere within a space of 350 cubic feet—extending from in front of it past midway back on each side, and from four inches to 7½ feet above floor level. It executes the needed motions all at once, after it's taught them one at a time.

No programing specialist needed. Any foreman or setup man can train Unimate. He attaches a simple "teaching harness," a string of pushbutton control boxes with buttons in opposed pairs. Each pair puts Unimate through one of its five motions—forward or backward, according to which button is pressed.

By pushing the right buttons, Unimate's teacher leads its hand out, sidewise, up or down, and suitably angled and swiveled by the wrist, to Position 1 of its intended job. Should it overshoot that point, he can make it back and fill

"Memory" of robot is this 30-inch-long drum, which goes in its base and stores up to 200 commands on magnetized metal strips. Drum rotates intermittently to bring each strip below a row of recording heads; and then, for playback, below a row of read-out heads.

until its positioning is accurate. Then he presses a "Record" button on Unimate's main control panel—and the hand's final position is impressed on Unimate's prodigious memory.

Thus Unimate may be given as many as 200 commands—which it will automatically carry out, one after another, in a single performance. Typically, each command instructs Unimate to move its hand, by a combination of its five motions, to a specified new position.

What Unimate is to do there is included in the same command. By using various controls, before hitting the "Record" button, the teacher can order the hand to grasp an object at Position 4—or to drop it at Position 18. He can tell the hand to wait so many seconds before going to a new position—a "time delay" used in cooling that die casting in the quenching tank. And he can direct Unimate, at any point, to start or stop an auxiliary device—a paint sprayer or welding gun.

With a whole program recorded, the robot's instructor presses a "Repeat Once" button. Unimate plays back all it's just learned, and stops—like an anxious pupil awaiting teacher's approval. If its performance suits its mentor, he presses another button—"Repeat Continuous"—to put Unimate to work.

The memory drum. Within Unimate's base is the secret of its learning ability—a magnetic drum turning intermittently to bring each of 200 lengthwise strips of metal beneath a row of recording heads. Pressing the "Record" button registers the hand's desired position in the form of numbers—which measures the hand's travel in each of its five motions. (Instead of conventional numbers, Unimate uses strings of 0's and 1's, the "binary" numbers that electronic devices understand.) Other instructions of a command go on the same strip.

In performing an assigned task, Unimate turns the drum to bring each magnetized command strip beneath a row of read-out heads. Obediently the hand starts moving—and Unimate's brainlike circuitry, noting the changing numbers that measure the hand's progress, constantly compares them with the ones on the memory drum. When all the numbers match, the hand comes to a stop. Unimate boasts a positioning accuracy within 50 1,000 of an inch.

When Unimate completes a once-only industrial task, the commands on the memory drum can be erased, and the drum used over again. A user can substitute a new drum and store the other in his "library," if the operation will be repeated at a future time.

Compact. Unimate stands 4½ feet high, on a four-by-five-foot base. Rugged, it's designed for five years of two-shift operation without a major overhaul. All it asks is kilowatts—no lunch, no sparing from heavy tasks, no retirement benefits. ■ ■

Will Unimate compete for your job? If so, chances are your job isn't good enough for you, answers its maker, Consolidated president J. F. Engelberger. Where Unimate shines is precisely at tasks that human workers shouldn't be doing, he maintains—jobs that are hot, noisy, hazardous, or monotonous. Since such chores don't bother Unimate a bit, Engelberger advocates: "Let our mechanical slaves release men from drudgery . . . and let's give men jobs that are worthy of men."

I Dive-Bomb Forest Fires

Coming in low and slow through smoke and turbulence, my air-tanker splatters tons of pink mud on a racing flame front

By John Streeter as told to Frank A. Tinker

WHO knows how this one started? A thunderstorm can touch off a hundred fires in summer-dry brush, and careless campers can be as bad. At the moment, the only fact of importance was that a tornado of flame had somehow started up the steep slopes of a Utah valley. Again somehow, it had to be stopped.

I received the Forest Service dispatcher's call in our ready shack, which also serves as a cooperative operations center set up at the airport by federal, state, and city agencies. Having been awarded the fire-attack contract for this area, I had the task—as did the turkey squatting on the ramp outside—of making all this support meaningful. In case you don't fly, a turkey is a retired Navy TBM—Torpedo Bomber Martin.

"Fire 40 miles north!" I hollered to the crew. Things began to hum. No one had to tell these experienced hands the importance of early control of a mountain fire.

Immediately above the flames lay a heavy growth of oak brush and pine. If the fire reached this explosive stand of forest, no small-scale control would be possible. An army of men and machines would have to climb other flanks of the range, setting backfires, slashing slopes with dozers and trenches. Then, with the first heavy rains, this torn and loosened mountainside would become a mud avalanche pouring off the bed rock.

John Streeter

The fire was already halfway to its objective, roaring up through the flue of a lower canyon. Putting men above it might be useless and dangerous; there was nothing on the rocky bluffs with which to fight. The grade was so steep here that dozers could not possibly cling to it.

So the Forest Service ranger had turned to the most effective weapon at his disposal—my turkey and its load of bentonite clay. Drought had simmered through the previous week, creating a "class four" (emergency) condition of high temperatures and low humidity. We had been standing by at the ready shack. Light planes

CONTINUED

"I sailed on through the fire, cinders rattling like popcorn on

were flying constant patrol over the mountains, hoping to spot those innocent white wisps that in hours could be infernos. Within five minutes after these tiny alarm flags were reported, our job was to have a loaded turkey on the way.

Now I recheck the fire location on our map. No chance of missing this one. The problem is simply whether we can handle it effectively. Jamming on a crash helmet, I make a last running check of the bomb-bay tank, climb the wing to the turkey's cockpit, holler "Clear!" and grind the starter. A quick warmup, a clearance from the tower, and within our time limit I am struggling for altitude over this mile-high, blistered valley.

At such moments, of course, you hope fervently that the Martins and the Wrights have put their machinery together in proper fashion. The R-2600 piston engine can gobble fuel in expensive floods as its 1,900 horses are whipped up, but it can also pull a full load to a fire level of 13,000 feet in remarkably short time. Empty, this squat battler weighs 10,800 pounds; but by the time fuel, bentonite, and my own bulk are aboard, this rises to 17,500. Maximum military gross is 18,800.

No war-weary crates. These surplus craft are really in excellent shape. This turkey, for instance, has only a little over 1,000 hours total flying time, and at 1,000 hours the Navy overhauls the airframe completely—even puts new skin on it. As for the engines, the most flight time on any in my brood is only 200 hours. They have to be in peak shape to avoid risk of breakdown during a fire.

Lifting off the runway, I hope the Forest Service rep has noted the proper time. At $250 an hour, each minute counts toward buying the 65 to 90 gallons of expensive feed this bird gulps.

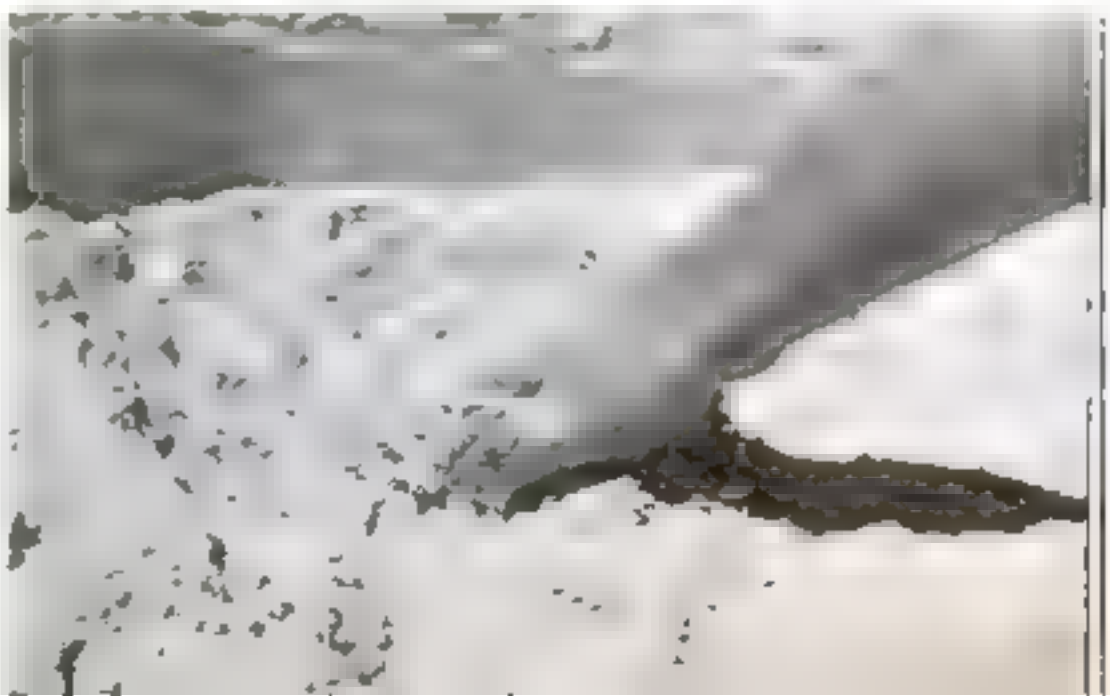
Each of the several hundred fire pilots in the country appreciates the concern of the Forest Service for his welfare. He knows also that the heavy toll—over 50 pilots—taken by previous fires almost caused these attacks to be abandoned. During the six years that fires have been bombed with retardants, however, techniques have been developed and experience acquired to reduce this combat risk. The Forest Service limits the types of planes that may be used; pilots must now qualify for assignment to battle. The previous spring I had attended the government school at Boise, earning a rating as an "initial attack" pilot by smothering a fire cagily placed between hills. Lads with less experience are graded "assault pilots" and cannot take on a fire alone. They're held in reserve for larger holocausts, and a Service pilot guides them over the target and directs the drop.

Today, however, the turkey and I are entirely alone, except for our radio link with the ranger on the ground. He will be in charge unless the blaze grows to such proportions that a professional fire boss has to be called in. It was such an enemy we had battled in Idaho's Salmon Forest the month before, where it had roared along a 17-mile front, keeping 2,000 persons on the fire lines and a score of bombers in the air.

This is war—make no mistake about it—with all the trappings: fighters sleeping where and when they can, villages overrun, both exposed to blistering attack at any moment, always the urgency of possible defeat and disaster.

"Ten-four, tanker four-nine-Charlie," the ranger's answer comes in clear on the

Bentonite, before water is mixed in, is a powdery clay mined in Wyoming and Utah. It has a remarkable capacity to absorb and retain water



the windshield"

In the TBM's belly is the tank that holds the saturated mud. A simple cable-release mechanism, visible at the forward end, releases either or both of the double doors on the tank. Rare, but anxiously remembered by pilots flying "on the edge," are the times when the heavy load fails to drop. The mud usually falls instantly.

air net when I call. "Looks pretty hot up there. Personnel on the south flanks now, may lift in a few by copter. Plan your own approach." My blaze is now in sight. Throttling back, I go in to look it over.

At first, the canyon in which this fire is centered seems almost impregnable to a drop. Flames and smoke whip up its giant chimney at a speed that might even hold part of the heavy clay aloft unless it were placed precisely. Absurd? Not at all. Currents aloft from the fires such as this have to be flown through to be believed. Approaching, a hundred feet off the rocks, I am tossed around like Las Vegas dice.

"Looks a little tight," I tell the ranger. "That rock abutment may make a pass from the south difficult. Do you have contact with those troops on the hill?"

"Negative contact. But they've all been briefed about the drop."

I know that, but being briefed in a quiet session and acting accordingly in the heat of battle are different things. These lads who volunteer to fight mountain fires are a hardy breed, and consider it a badge of honor when they are splattered with falling chemicals. Unfortunately, they may not realize just what kind of punch this mud carries. At least one firefighter has been killed under its crushing load. I have seen a jeep flattened completely, a pickup brushed off a hill, and holes drilled through aluminum helmets by rocks squirted out from under this 100-mile-an-hour flood.

When the first drops were made with plain water, the fires simply spat it back into the air or changed it immediately to ineffectual steam. Now borate or bentonite is invariably used. The bentonite my turkey carries is a clay of volcanic origin, dyed pink so it can be seen better. It retains its load of water for about three hours under adverse conditions. Sodium calcium borate stays damp longer but is heavier, more expensive, and sterilizes the soil. Either is deadly when a ton of it cascades down on an unprotected person.

I make the first pass over the great bubbling fountain of smoke that partially obscures the rocks. I memorize the terrain, the wind direction, and the natural barriers to the fire that my clay would supplement if placed properly. Just above the main fire is a broad face of rock, which might hold our enemy if the blaze can be dampened enough to prevent sparks from crossing it.

Two flank drops could go along the front tangents of the blaze, falling partly on the worst of the flames, partly on the dry firs, already smoking, that are next in line. This would subdue the fire and permit the ground troops to move in with their shovels. A few more drops would close this flat triangle and wet down the tinder at the top of the rock face.

Coming in for the first drop over the

CONTINUED

rock escarpment will be tricky. This glide has to be planned even more carefully than usual, not only to leave the escape route open as required by the Forest Service, but to bring me to the top of the cliff just above stalling speed. Ordinarily, the approach is flown so that your slight glide plays out just at drop point. But this would be only the first part of this approach. The Service demands that all runs be made either downslope or across a level. A flat run with the turkey means an increasingly nose-high attitude at slow speeds, and with 20 or 30 degrees of flaps this is no configuration for comfort. If the engine barks or the clay doesn't drop, there can be roast turkey for the boys below.

I arrive at these rocks just as 85 knots slides past the air-speed indicator. I drop full flaps, chop throttle, and shove the turkey's nose over the brink and into the smoke. But—no drop! The fire is there all right, but the incline of the slope is too steep for good coverage. To drop the bentonite now might make a fine splash and a little steam, but would do no permanent good. I restrain an itching hand on the drop lever and sail on through the fire, its debris and cinders rattling like popcorn against the windshield.

"Negative drop," I tell the ranger. "Very poor angle. We'll try the north."

A 180-degree approach pattern puts us level with the fire again, this time flying toward the rock abutment that shows occasionally through the smoke. Peeking through such a waving white curtain, you can understand why one kid on the big Salmon blaze had answered the Forest Service guidepilot's instructions to attack with this cool suggestion: "You lead, I follow, Buster. When you come out the other side of that smoke I'll go in this side."

And, as they always have, the Service pilot there led the way.

This time the turkey and I figure we're right. A clean approach, a blazing target, and an upslope that can catch the clay evenly. Then a fast pull-up and wingover away from the rocks. At this angle the drop itself can be accurate to a foot. Once I knocked out a blaze growing from a campfire in front of a fisherman's tent. I always wondered what he thought when he came back and found his site a mess of pink ashes and mud, his canvas only spattered.

100 . . . 90 . . . 85 knots. The flaps are down, throttle retarded, r.p.m. set at a climb 2,250, the stick soft and creeping back in my lap as I crank in some help from the elevator trim tabs. Just below the pregnant belly of the turkey, rocks give way to the first pines of the canyon. Smoke and heat bounce us again. Then there is the target, and beyond is the waiting bluff. . . .

Right then you pull the drop lever and scram!

Free of its three-ton load, the turkey leaps. You don't *hit* the throttle or *kick* the rudder, not at this speed. Rather, you make a fast, coordinated turn, watching for inevitable downdrafts in the lee of the fire, and ease the gas to the gobbler as fast as he will accept it. Above such a concentrated fire, where the oxygen content is low, the engine can blot out.

Then we are through and away, and I can look back to see what has been accomplished. A fir tree ablaze an instant before is now a steaming wreck, no longer dangerous. Where there was a racing orange streak of ground fire there is now a flat slash of pink mud 100 yards long and 30 yards wide. The blaze has come up against a barrier, and behind it a ground attack can be launched.

At such moments fire pilots forget about pay (a downright blasphemous idea in this trade) and join the fight as just another soldier. I've seen them carried away by this surge of morale and, even though Uncle Sugar pays by the minute, risk the ruin of their engines by fireballing back to the base at wide-open throttle.

I make a short circle to see where the next drop should go.

"That got it!" the ranger is exulting on all 168.1 megacycles. "Now put one right beyond!"

We whip back to the airport and an-

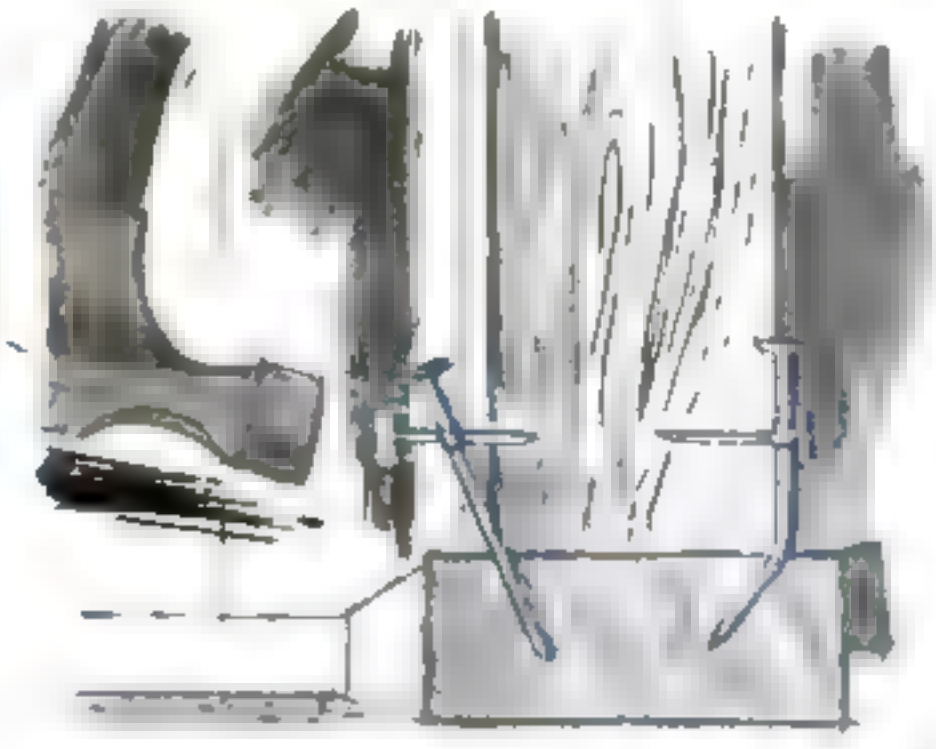
[Continued on page 170]

Cable unloads moving plane. Cargo too heavy for parachuting could be speeded to a remote military or disaster area, according to this recent patent, by anchoring a spring-loaded arresting cable across a clearing. To unload without landing, the pilot would touch down, let a tail hook pull out his palleted cargo, and zoom off.

New ideas from the inventors

Cleats convert your shoes. You could step out on the links in any shoes if you slipped on these molded-nylon cleats. A slotted screw between toe and heel portions would adjust the length; roller-skate-type clamps and a heel-locking screw would fasten the cleat plate securely to your shoe.

Dual nail locks itself. Pairing a short nail with a longer eyeletted one could make toenailing simpler and safer. You'd avoid splitting by driving the long nail at—rather than through—the corner of a stud. You'd then drive the short nail through the eyelet (right) to lock the pair in place.



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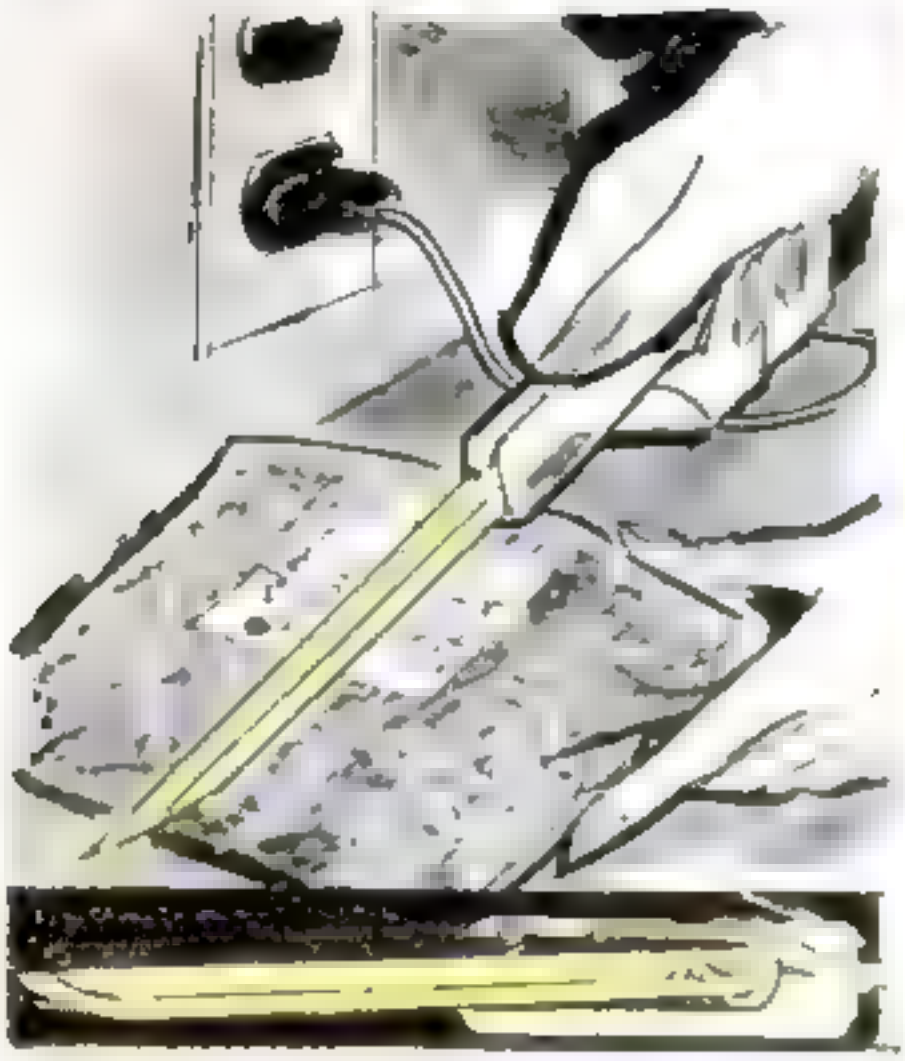
More inventors' ideas



Knife heats on the job. After cutting apart frozen food with this electrically heated knife, you could safely park it on a counter top. A pivot mount in the handle would let the blade heat up only under cutting pressure, turn heat off when pressure was released. A thick handle would keep the blade clear when the knife was laid down.

Bell push lights porch. Visitors wouldn't wait in the dark at your door if ringing the bell also turned on a porch lamp. A delay switch would turn off the lamp after a preset interval, so it couldn't be left on by oversight. The light would let you identify callers, and you could use the system to light your own way out of the house.

Rack turns fireplace into grill. A sudden rain might shift a barbecue indoors, but it wouldn't wash it out if you had a fireplace post like this. A vertical slide would adjust its length so that the leaf-spring base would force the upper plate against the fireplace opening. Slots at intervals would hold a grill and a charcoal-broiler pan.

Oar tip poles boat. You could push a boat off a sandy beach or muddy bottom with little effort if you had an angled attachment like this bolted to the tip of your oar. For poling, the light, metal tip with projecting squares would make a nonslip pusher; for rowing, it would give some of the scoop effect of a hooked racing oar.

Reel steadies gas pedal. With this reel of wire in a slot through your gas pedal, you're promised even pressure with a gentle touch. One end of the wire would be anchored to the floor, the other to a groove in the reel. You'd roll the wheel to feed gas, press lightly to "lock" the pedal. A downward push would feed gas in the usual way.

Safety foot levels ladder. An adjustable outrigger on one or both legs of a ladder could level it on uneven ground, keep it from tipping even if you leaned far out. When not in use, the extension leg would telescope and the angled support would fold flat against the rail.

The following patents have been issued on these inventions: **Unloader**—*No. 3,017,163 to W. D. van Zelm, Buxton, and M. A. Jackson, Box 6747, Brookhaven, Miss.;* **Cleats**—*No. 3,025,615 to J. K. Patton, Odessa, Tex.;* **Nail**—*No. 3,019,686 to W. L. Behrle, Rte. 1, Fenton, Mo.;* **Knife**—*No. 3,024,342 to R. R. Birnbach, Yonkers, and E. Millner, Hartsdale, N.Y.;* **Bell light**—*No. 3,017,623 to C. J. Buhofberger, Minneapolis;* **Barbecue post**—*No. 3,016,894 to D. E. Cleary, Dennisport, Mass.;* **Posh oar**—*No. 3,025,538 to R. F. Noland, Waycata, Minn.;* **Pedal holder**—*No. 3,023,633 to R. F. Tudor Jr., Bridgeton, N.J.;* **Ladder foot**—*No. 3,025,926 to J. C. Voss, Jamaica Hills, N.Y.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington 25, D.C., at 25 cents each. To write to an inventor, if the address given above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

Mouse that has never been sick and never will be is swabbed for test injection by attendant.

Life in a Germfree

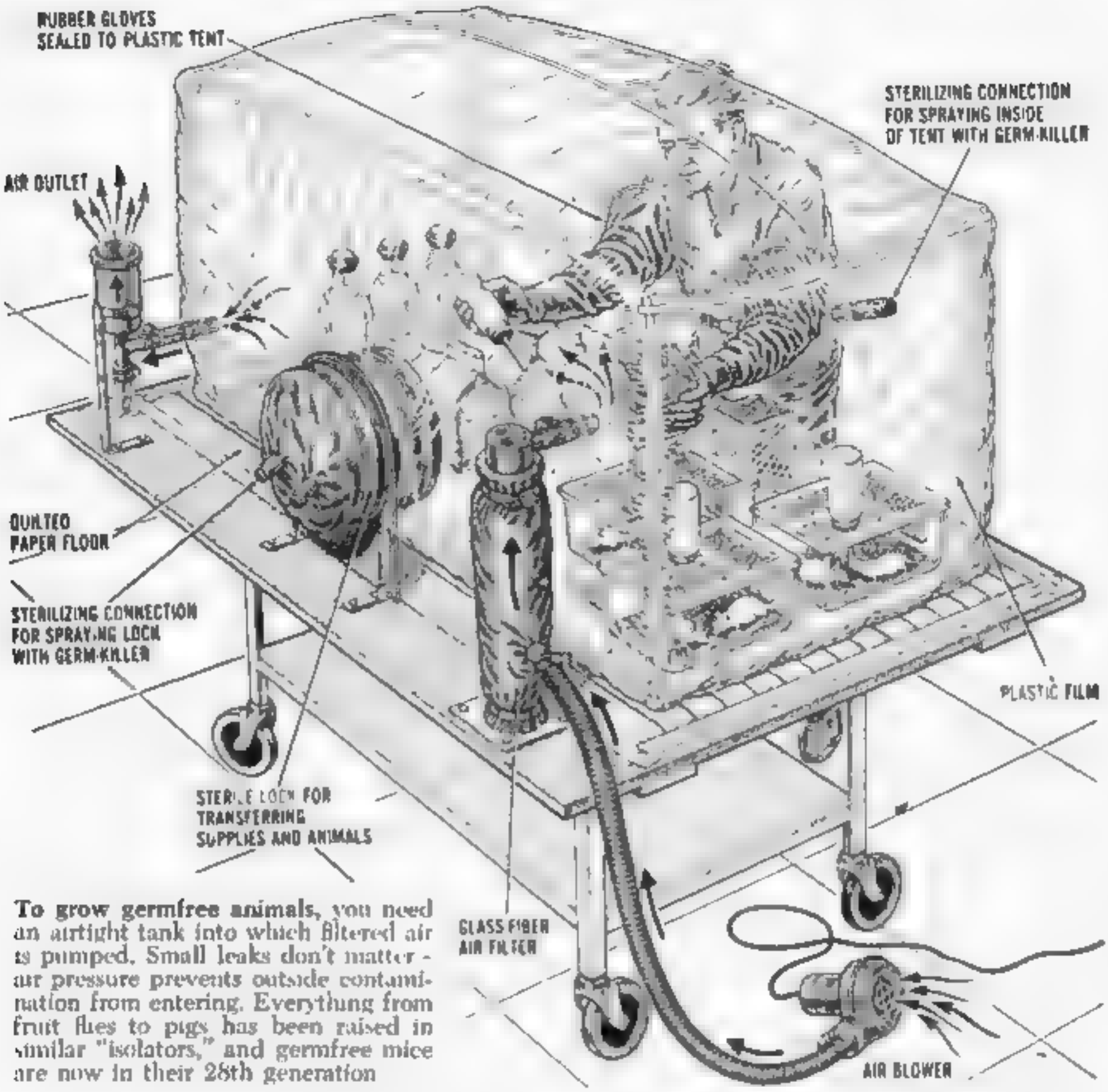
By Robert Gannon

IT WAS after hours when I walked into the laboratory. The central air supply murmured lonesomely, punctuated by the occasional squeak of a mouse. Pools of soft light, streaming from the observation ports of the stainless tanks, dappled the floor. Eerily, 25 pairs of arms growing out of the cylindrical tanks waved at me.

They weren't really arms. They were long rubber gloves puffed inside out by air pressure inside the tanks and flexing in time with the pumps.

The gloves offer the only access to the mice—1,500 fuzzy white mice that have no infections, no tooth decay, no disease. They have never been sick, they never will be. These mice are completely free of germs.

Already, in a dozen labs across America, animals like these—chickens, rats, hamsters—are living out their lives with-



To grow germfree animals, you need an airtight tank into which filtered air is pumped. Small leaks don't matter - air pressure prevents outside contamination from entering. Everything from fruit flies to pigs has been raised in similar "isolators," and germfree mice are now in their 28th generation

World

What would happen to human health in a world without infectious diseases? A startling new science—gnotobiotics—may supply the answer

out a single germ within sneezing distance. Every year more scientists join in this strange study known as gnotobiotics (pronounced *no-toe-by-ah-tics*). For the ability to grow lab animals that, generation after generation, have never known germs promises to save human lives and ease misery.

● At the University of Arkansas, Dr. J. J. Landy took out a man's appendix under a germfree plastic tent. Exulted Dr. Landy: "It is now possible to operate without contamination . . . We are entering an era of truly sterile surgery."

● At the National Institute of Dental Research, germfree hamsters have perfect teeth until deliberately exposed to one kind of bacteria. The goal: a decay-preventing vaccine.

● At Walter Reed Army Institute for Research, germfree guinea pigs die of infection 48 hours after leaving their sterile world. Germfree rats and chickens rarely even get sick. Why? Is there a substance

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that protects rats and chickens? Could it be synthesized for humans?

Scientists once believed that germs were necessary. Pasteur said: "Without bacteria, life would become impossible." Early attempts to raise germfree animals seemed to prove him right.

The first containers leaked and contaminated the animals. The creatures had had no chance to develop resistance, so even a common cold killed them.

In early days little was known about diet. Vitamins are manufactured by some bacteria. So unless a germfree animal is fed vitamin pills, he dies of malnutrition.

THAT these difficulties have now been conquered is due largely to a man who combined his family's tradition for precision machinework with his own passion for bacteriology. At Notre Dame University in the late 1920s, James A. Reyniers became fascinated by the discovery that a "friendly" germ might, during one part of its life, turn very unfriendly—cause disease.

Reyniers isolated bacteria and studied their cycles. But when he injected them into laboratory animals, he ran headlong into a frustrating problem. If the animals sickened after an injection, was the cause the single strain of bacteria, or did the injected bacteria make *other* germs produce disease?

One road to the answer was to use animals free of germs. But there weren't any. Reyniers proposed a mammoth, 50-year program to develop germfree life. To his surprise, the plan was approved.

First hurdle: apparatus. "My people have always been machinists," Prof. Reyniers told me recently. "My father, brother, and I invented a whole line of germfree equipment—apparatus to take care of anything from houseflies to fish to pigs." (Reyniers & Son, Chicago—owned by the professor's father and brother—is still the largest manufacturer of gnotobiotics equipment.)

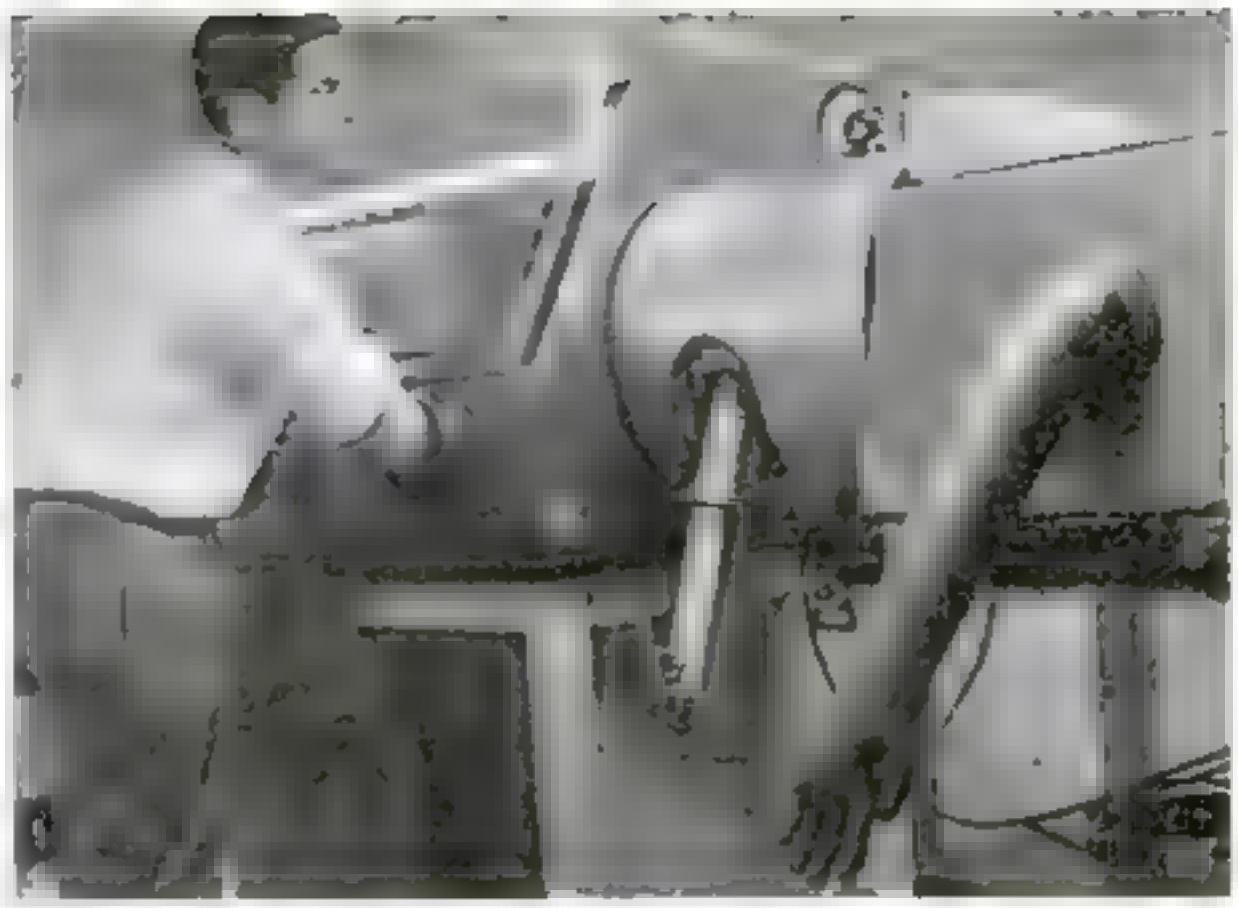
The early period at Lobund (*Laboratory of Biology at the University of Notre Dame*) saw heartbreak alternate with triumph. "Once I lost nearly every germfree animal I had," said Reyniers. "Somehow the main thermostat stuck, and temperatures in the units pushed above the survival point. In a single hour, 10 years of work was wiped out. You don't have many decades in your life to repeat."

At other times the air pumps stopped when power failed, or leaks allowed bacteria-laden air to seep in. "During one period we oversterilized the food," said Reyniers. "The diet lost vitamins, but we didn't know it until we found a roomful of sick animals."

Yet by 1960—30 years instead of the expected 50—Reyniers had developed

Huge germfree tent at the Notre Dame lab is so big that researchers climb inside to tend animals. Opening in tent floor has sealed to it a plastic suit, jacket, hood, gloves, and air hose for breathing. To get to work, man wriggles up through opening and into suit. Plastic-tent isolators are coming into use in many laboratories because they are cheap; materials can easily be assembled by students.

against infection



Stainless-steel tank developed by Dr. James A. Reyniers during 1930s and 1940s made possible first successful germfree life. This one, at University of Michigan, is connected to an autoclave (cylinder in center) that sterilizes food and materials going into tank. Operator works through port holes fitted with rubber gloves like one at right. Air pressure makes it stick out

equipment and techniques to keep germfree animals alive. He left Notre Dame two years ago, but Lobund, now directed by Morris Pollard, continues as a major center.

The techniques are marvelously ingenious. Most laboratories continue to raise germfree animals inside stainless tanks, although some—following the lead of Lobund's P. C. Trexler—are switching to cheaper plastic tents.

TO GROW germfree animals, you need a sealed chamber, a double door for sterile entry or removal, fiberglass filters through which sterilized air is pumped, viewing panels, and shoulder-length rubber gloves set into portholes.

Each isolator is sterilized with live steam—like a giant pressure cooker—before animals move in. An autoclave at one end of the tank sterilizes instruments, bedding, and food that are added later. (One problem eliminated: food spoilage. In a germfree world, nothing rots.)

As you look into an isolator, the germfree animals seem like any others. Droppings litter the cage bottoms; food is spilled and trampled. You wonder if the unit is *really* free of germs. You wonder, too, if a few bacteria mightn't be lurking inside the animals.

Nature helps out. Explains Dr. Walter L. Newton, director of the germfree laboratory of the National Institutes of Allergy and Infectious Diseases: "Until birth, young are naturally germfree."

Scientists need only make sure the animals are born in a pure atmosphere, either from germfree mothers or through sterile Caesarean sections. To maintain their purity, germfree babies cannot come in contact with conventional mothers. With birds, this presents no problem. The egg hatches germfree. Rats and mice also are easy. They give birth in isolators. But guinea pigs and rabbits will not.

So germfree guinea pigs are removed surgically from normal mothers. The operating chamber has a porthole in the bottom, covered by cellophane film. The pregnant sow is strapped upside down under the unit to a miniature operating table, and raised so her belly is pressed tightly against the cellophane membrane. Working with rubber gloves from within the tank, researchers deliver the baby animal into its germfree world.

Perhaps the most dramatic research is in the study of space life. Scientists at Walter Reed are attempting to breed germfree monkeys to send to the moon and planets.

One scientist even suggests germfree men to explore space. Says Dr. Charles Phillips, "All we have to do is keep a man in a germfree cabinet for some 25 years following birth, meanwhile teaching him how to fly a spacecraft." Dr. Phillips is only half joking. ■ ■

First Air-Cushion Ferry Skims Water at 70 m.p.h.

THE world's first scheduled Hovercraft service started last month (July) in Britain, ferrying passengers across the Dee estuary near Liverpool. The Vickers VA-3, operated by British United Airways, skims over the water at up to 70 m.p.h., and does the 15-mile journey in 20 minutes. By road, it's a two-hour drive.

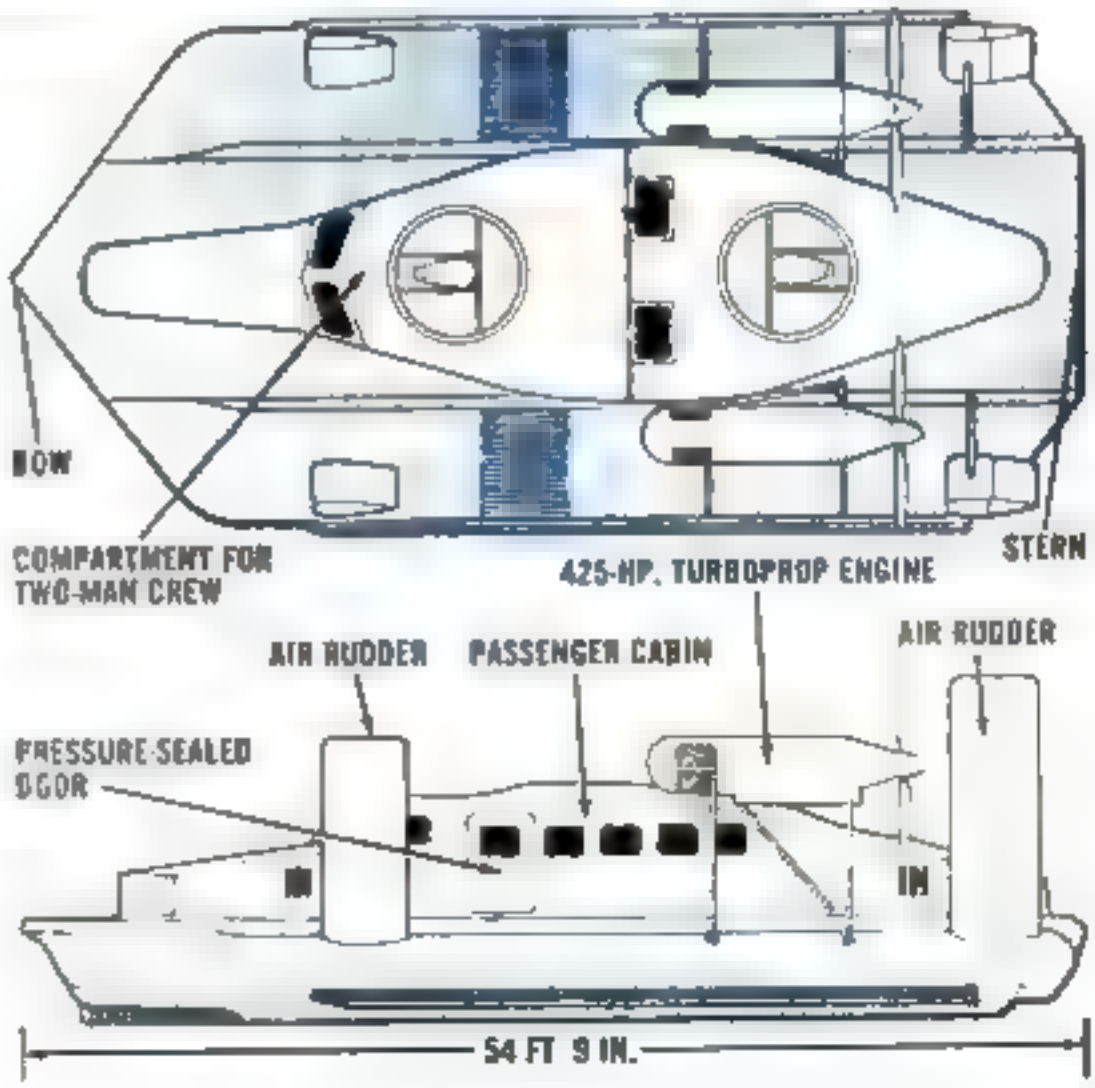
An aircraft-type cabin has rear-facing seats for 24 passengers. It is sound- and water-proofed by double-glazed windows, insulated walls and roof, and pressure-sealed doors. A separate compartment for the two-man crew is in front. Single fare is £1 ($2.80).

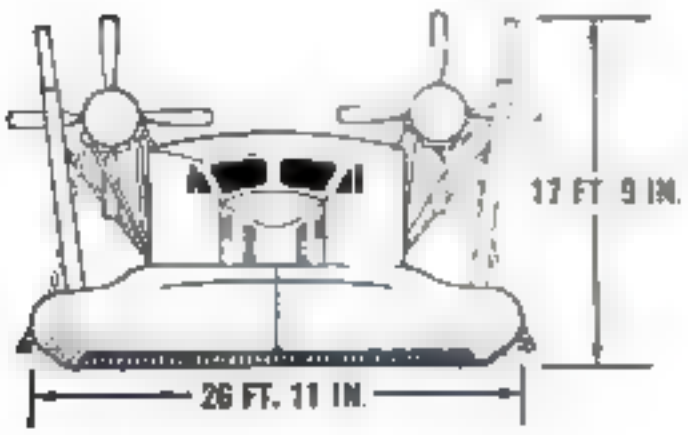
Normal hover height is 8 inches, but at high speed the machine can clear 27-inch waves on choppy water. Should lift power fail, buoyancy chambers in the hull enable the VA-3 to proceed safely as a normal floating boat.

Since the fast air-cushion vehicle is a potential danger to coastal shipping, it is identified by a special flashing amber beacon in addition to the usual marine lights. Navigation is assisted by radar, and there is constant radio contact with the shore stations at Hoylake and Rhyl in North Wales, where reserved beaches serve as terminals. —*David Scott*

Rear view of VA-3 Hovercraft during tethered testing is shown above. Ball-tipped probes, barely visible at the corners of the hull, contact ground or water to indicate height

Ten-ton craft is powered by four 425-hp. turboprop engines, two for propulsion and two for lift. Under way, steering is by tall rudders at the four corners. While maneuvering and taxiing, machine is steered by deflecting the jet curtain outward at one of rear quarters. Propellers are reverse-pitched for braking





Dry Run to

Stand-in for Mariner, this 450-pound space probe soon to make a three-month trip to Venus, is shielded hangs in special shroud within space simulator's vacuum chamber before tests

Venus

By Wesley S. Griswold

80-foot space simulator looks like silo atop boxlike barns.

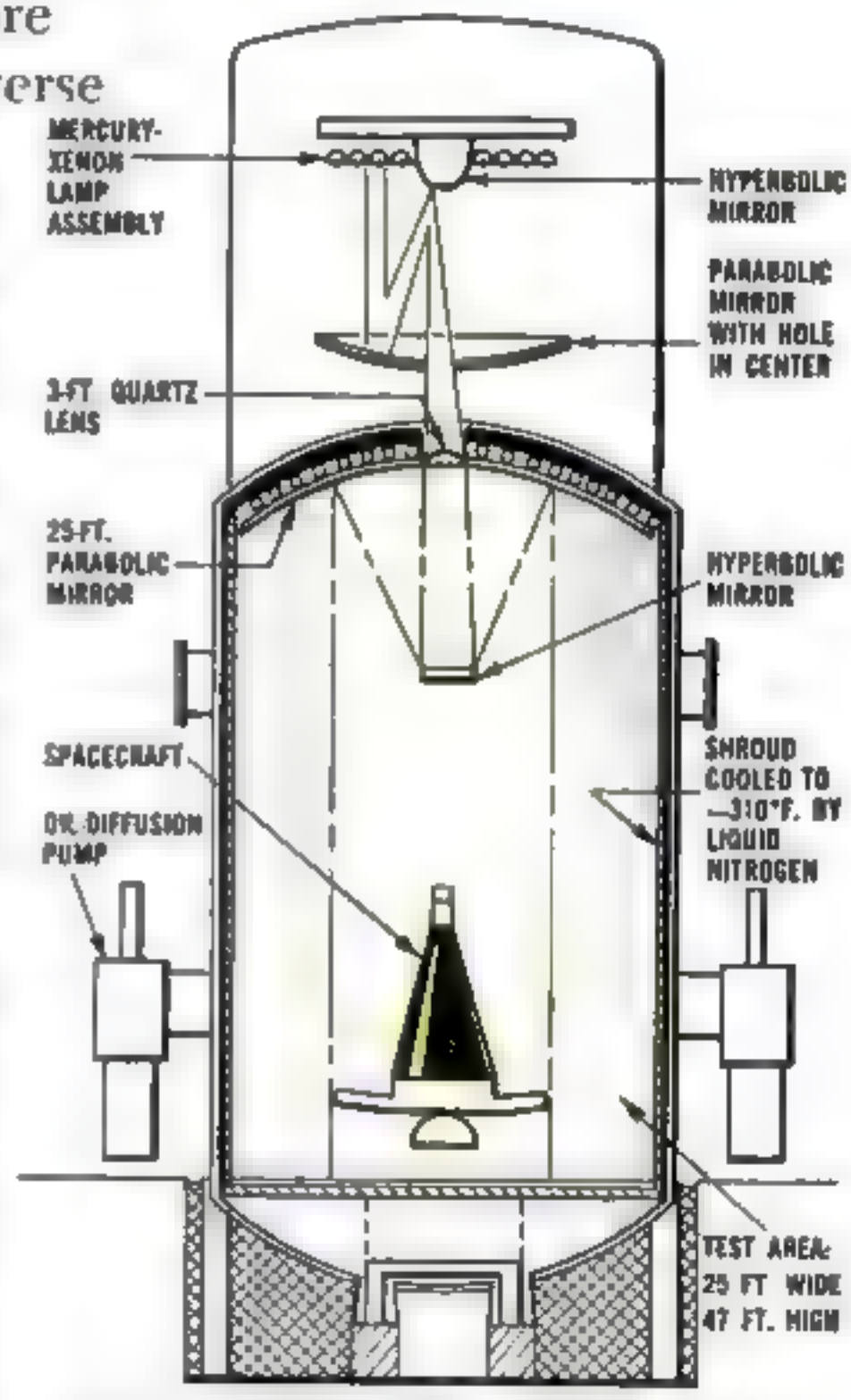
The cold, airless environment of space in this silvery tower will test spacecraft before they venture out into the universe

SOME day this month, a 450-pound space traveler named Mariner is scheduled to be hurled on a 26-million-mile journey from Earth to Venus. Mariner has never made the trip before, but it'll seem like an old story.

A stand-in for the 10-foot space probe, which resembles a bell buoy until it spreads its 14½-foot solar-panel wings, has already had a three-week sampling of what to expect en route. It spent the time in a tall, silvery, tubular building recently erected on the grounds of Caltech's Jet Propulsion Laboratory in Pasadena. There, it found out for big-brother Mariner what space travel is like.

JPL's gleaming new space simulator, as the building is called, is 80 feet high and 27 feet in diameter. It looks as humdrum as a silo, but it performs dramatic and highly useful feats for science. It can imitate the frigid airlessness of the vast reaches between stars. It can also duplicate the effects of the sun on spacecraft traveling between planets in our solar system. Soon, with a vibration table added, it'll be able to mimic the tremors of a space probe during retrorocket firing or mid-course maneuvers.

Spacial shin roast. "A spacecraft under way is in somewhat the same predicament as a person standing before a roaring fire in a cold house," says William R. Howard, a top JPL engineer. "One side is in danger of getting too hot, while the other side is too cold."



Intricate path of artificial sunlight is shown in cross section of simulator. From the bank of lamps (top), beams fall on spacecraft in same plane as would the sun's rays.

With the spacecraft, this is a matter of life or death. If its electronic gear should bake or freeze, all our effort to learn more about a sister planet would be a total loss, a $12,000,000 waste.

"What we have to do," Howard ex-

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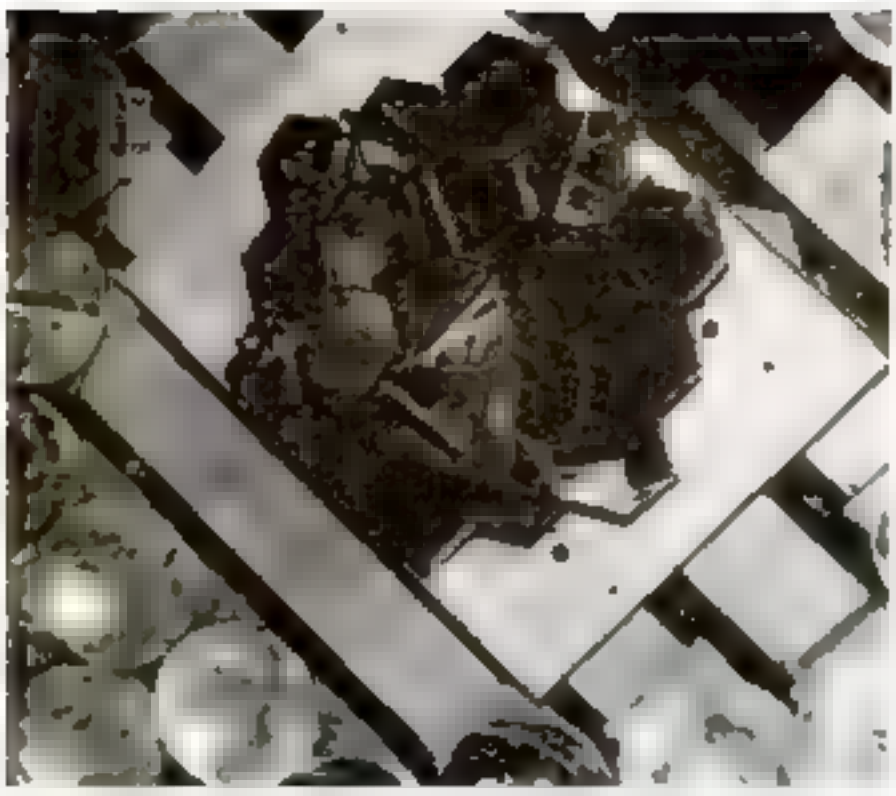
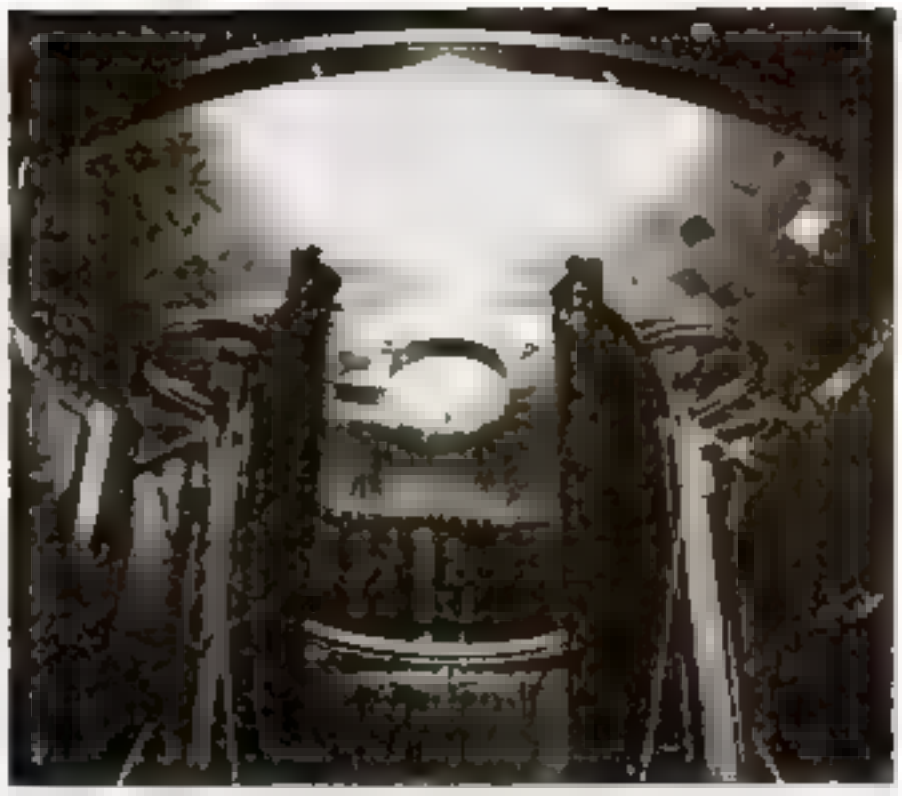


Nest of hyperbolic mirrors, of polished metal, lies among rows of sun-lamp reflectors. The mirrors, water-cooled against heat, beam light through lens in test-chamber ceiling.



With only three lamps turned on out of 131, this dramatic beam of imitation sunlight poured through the ceiling of the test chamber of JPL's $4,000,000 space simulator.

plains, "is design a craft that has the right color, finish, material, and shape to absorb just enough solar heat to stay warm all over on its journey."

To accomplish this, they needed an environment just like space in which to test temperature reactions of interplanetary birds before they fly. They got it in the $4,000,000 space simulator.

Assembling artificial sunlight, these men are at work on one of the 2½-kw. mercury-xenon lamps that are mounted in rows at the top of the space simulator. Each lamp has a 16-inch reflector

In its dull-black interior, painted to help absorb radiated heat, it can produce a vacuum equal to one-billionth of the earth's atmospheric pressure at sea level. Impressive as that seems, the perfect vacuum of space is still a billion times less. However, the difference between the imitation and the real thing is far less important than it may appear to be.

Not a breath of air. "Think of space as a five-room house without a particle of air in it," suggests Howard. "Then imagine letting loose in that house a glob of air no bigger than a pea. That tiny trace of atmosphere represents the degree by which we fall short of duplicating the absolute vacuum of space."

Air is drained out of the vacuum chamber in a three-stage pump-down. Seven compressors that used to run JPL's supersonic wind tunnel man the first stage. Three vacuum blowers take over from them. Ten oil-diffusion pumps then finish the job. These last keep pumping all the time a spacecraft model is in the chamber, to remove any smidgen of gas or vapor that might ooze from the craft in the glare of artificial sunlight.

The walls of the vacuum chamber are built of stainless steel that can take more than 1,000 pounds of pressure per square foot. Otherwise, atmospheric pressure would crumple them like cellophane.

[Continued on page 178]

Twin-turbine cargo copter lifts 10-ton loads

The free world's largest helicopter, the new Sikorsky S-64 Skycrane, is undergoing flight tests, picking up huge objects like the 8-by-20-foot truck trailer above. The sky workhorse can handle cargo weighing more than 10 tons at a cruising speed of 110 m.p.h.; top speed is 122 m.p.h. Its 72-foot-diameter, six-blade rotor is spun by two Pratt & Whitney turbines.

The S-64 is an outgrowth of Sikorsky's first Skycrane, the piston-engine S-60 built in 1959. It carries twice the load.

Automatic teller checks your deposit

Now you can bank by vending machine. A customer makes a deposit at right in one of them at a midtown branch of New York's First National City Bank. The Bankograph accepts currency, coins, and checks, photographs the deposit slip and each item on succeeding frames of 16mm film; and returns a receipt. Another machine is in a downtown branch of First National City, and a third robot is in a bank at Stamford, Conn. With a Ready Teller, customers won't have to wait in line at a teller's window just to make deposits.

One-room trailer schoolhouses

Summer sessions at Chicago's South Kildare Ave. school are being conducted in 26 new single-unit classrooms. They are trailers parked on a vacant lot next to the school building to care for overflow students. Each will hold 30 pupils, is air-conditioned and well lighted.

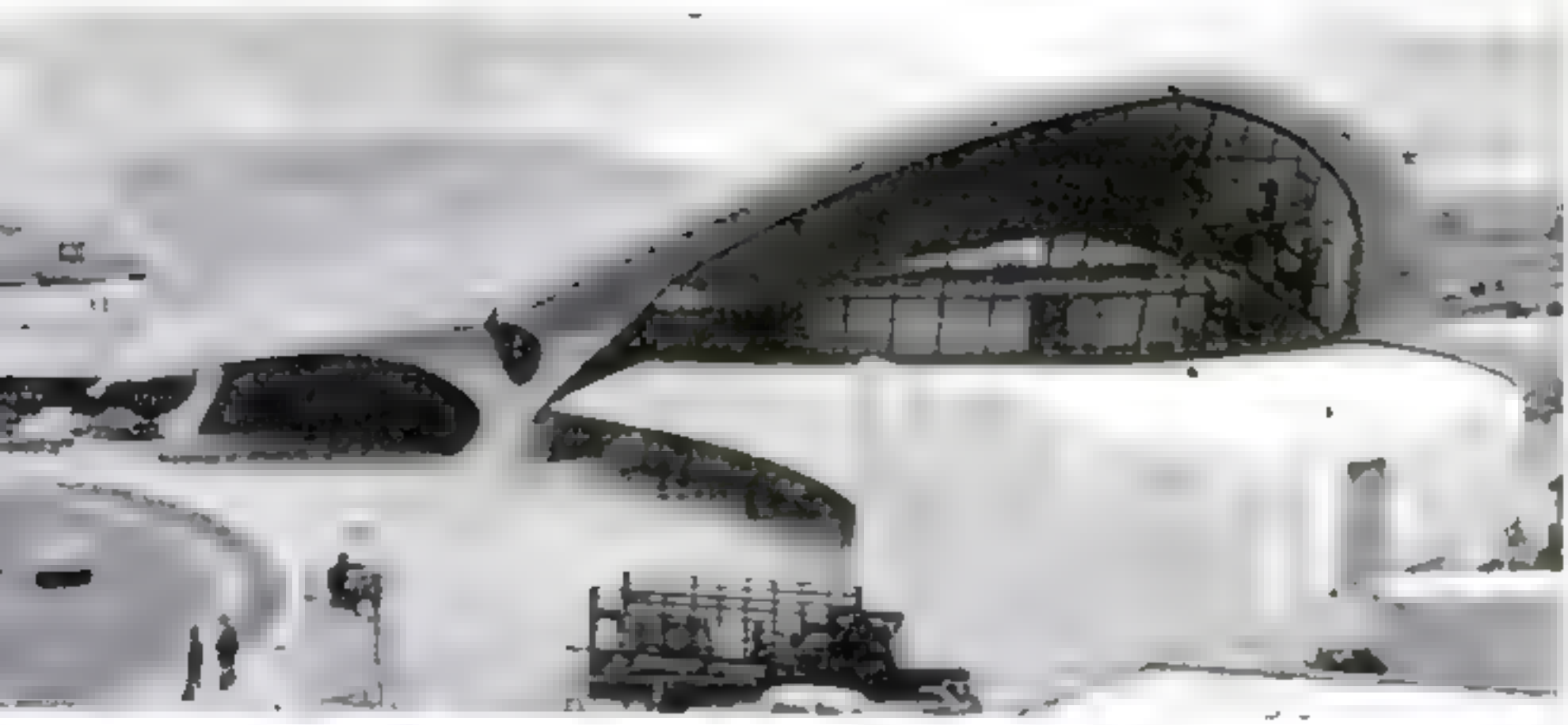
The Board of Education plans to buy 150 more to relieve overcrowding. They cost $8,450 each, plus $1,500 installation.

Nation's newest air terminal is a giant concrete eagle

A huge bird with wings spread for take-off—that's what the new TWA terminal building at New York's International Airport looks like. The sculptured work of art was designed by the late Finnish architect, Eero Saarinen. The 11,500,000-pound roof stretches 310 feet from wingtip to wingtip and 230 feet from beak to back. Its reinforced concrete is 44 inches thick at center and tapers to eight inches at the edges. The span covers a tiled floor area of 1¼ acres with no pillars or rafters to break its arched sweep. The beaklike extension at front is a downspout—during rain it splashes a pic-

Growing gardens under the sea

Who says our new nuclear submarines are just World War II pigboats that can stay at sea longer? Submariners on them eat as well as anyone at home. In hydroponic "window boxes" under fluorescent light, commissarymen grow fresh vegetables and salad greens even when submerged. Growing medium is tap-water-flooded vermiculite and a nutrient containing various nitrates, sulfates, and phosphates. Lettuce can be harvested in three weeks. Other crops are radishes, cress, celery, broccoli, peas, chard, parsley, carrots, and turnip, collard, and mustard greens.



turesque waterfall into a pool beside the main driveway.

Inside the terminal, passenger service is fancy, too. Checked baggage travels to the plane-loading area on high-speed conveyers. Incoming passengers receive their luggage at the rim of a merry-go-round device fed by chute. Flight information is posted on two big boards by pushbutton from a control tower atop a flight wing where passengers board and deplane. It is relayed to other areas by closed-circuit television.

Passengers will board and leave planes through covered corridor extensions.

Automatic help for bowling a spare

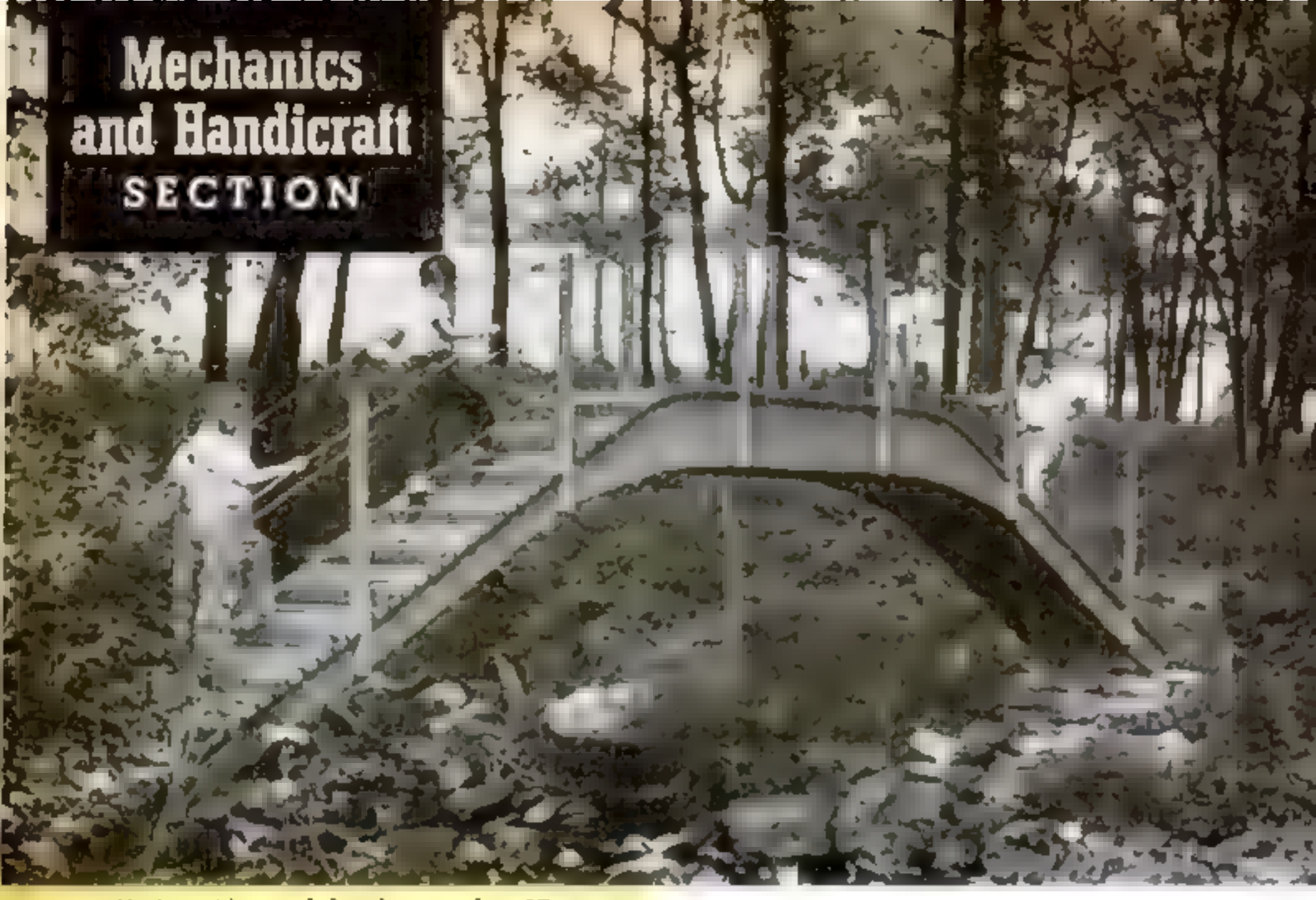
If you fail to make a strike on a new bowling alley, an illuminated panel at the end shows where to aim the second ball for a spare or the next best score.

The position of remaining pins flashes electrically on the panel with an arrow showing where to aim.

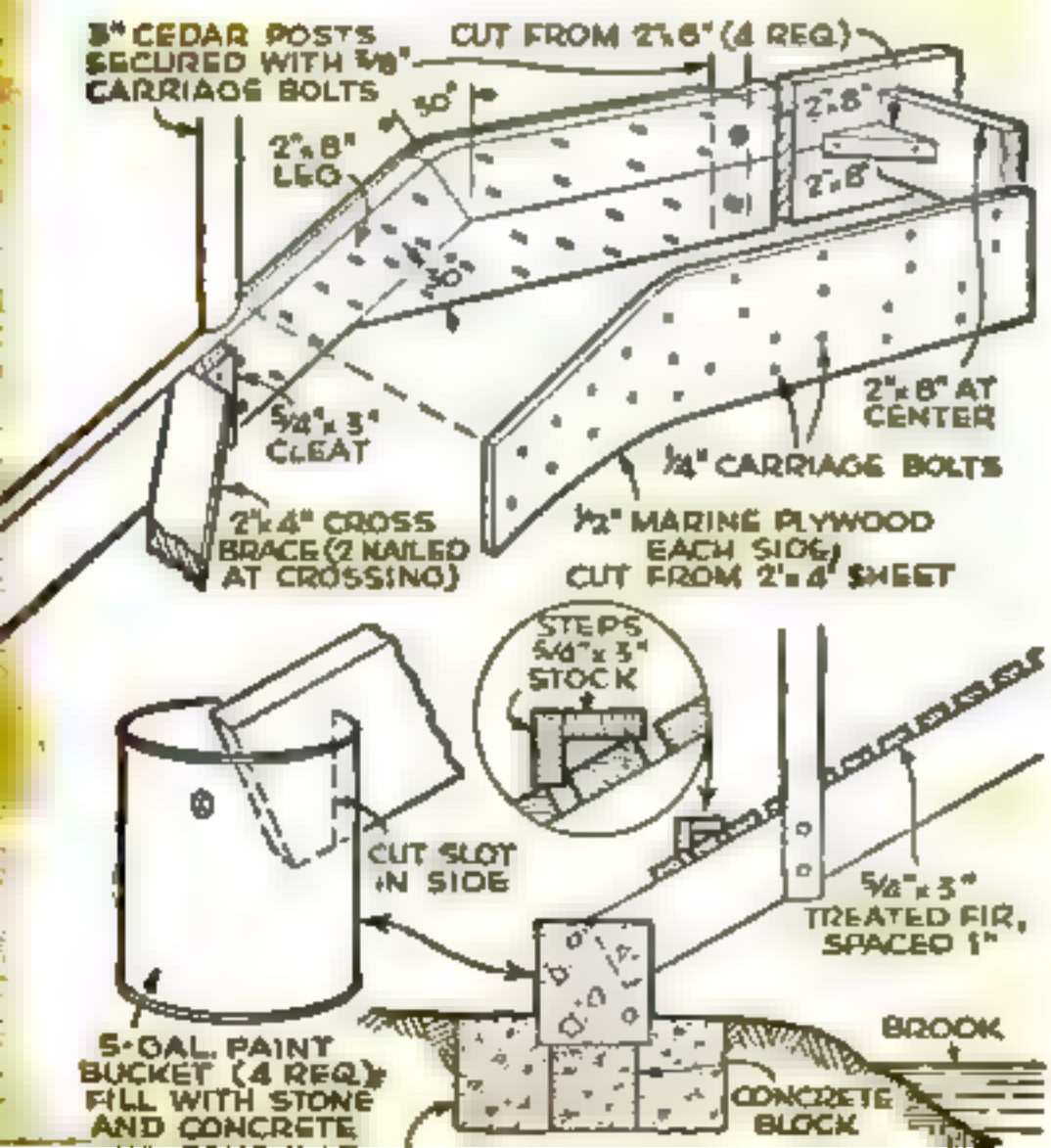
In the position at right, with the 1, 3, and 6 pins left, the lighted arrow indicates the best shot is in the pocket between 1 and 3, with the likelihood that the 3 pin will carry the 6 with it.

The AMF Sparemaker is programed to light one of 11 arrows, to indicate a correct ball path for any of 1,023 possible spare leaves.

Mechanics and Handicraft SECTION



High, wide, and handsome, this 27' truss bridge was designed and built by Roy [illegible] of Mountainville, N. J. Center truss sections are two two-by-eights, bolted together and to the legs with tie plates inside and out. All eight plates were cut from one panel of ¼" marine plywood, waste triangles being saved as gussets. Concrete piers were cast in big cans with leg stock in place to form a socket. Trusses are 36" apart.



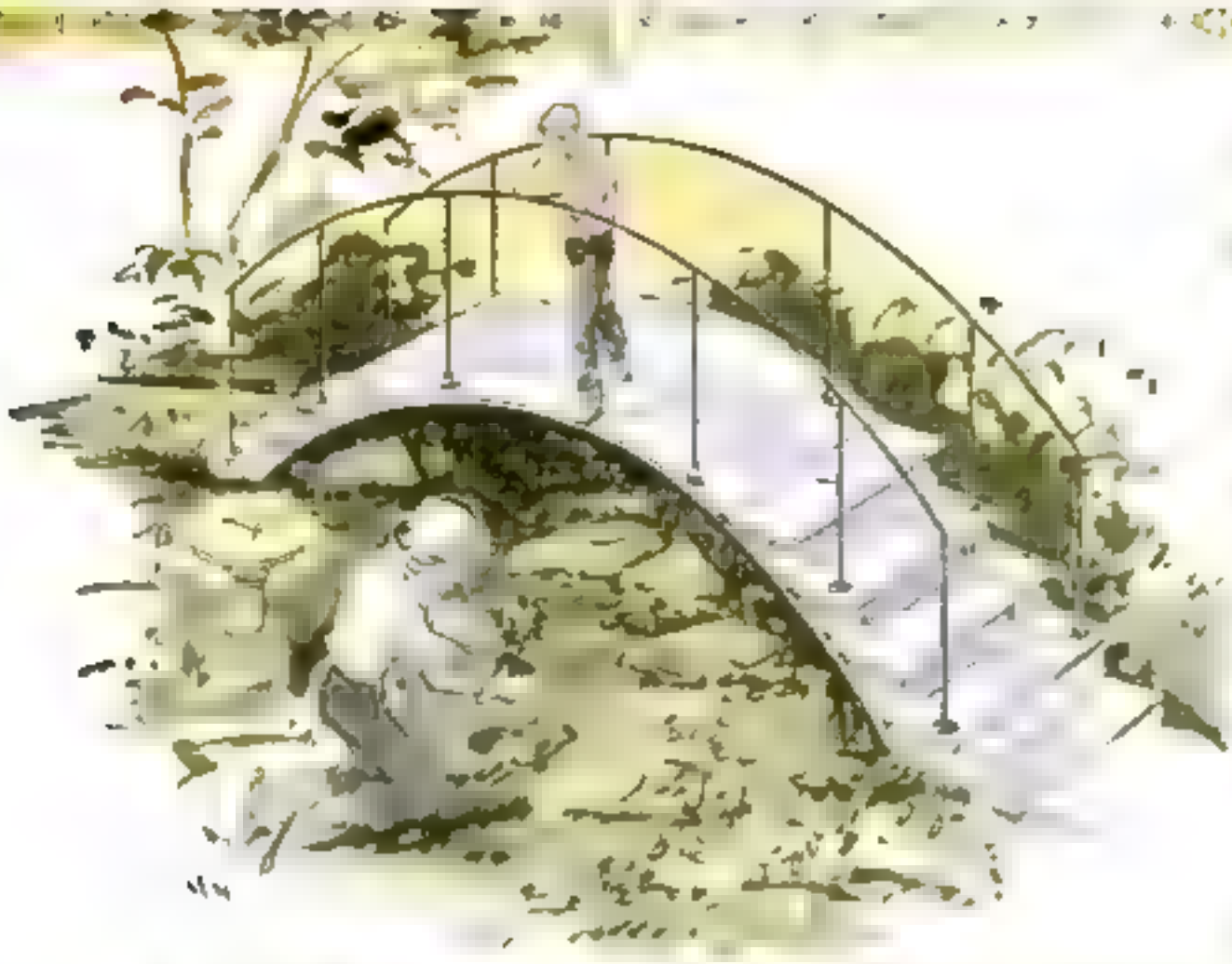
Build

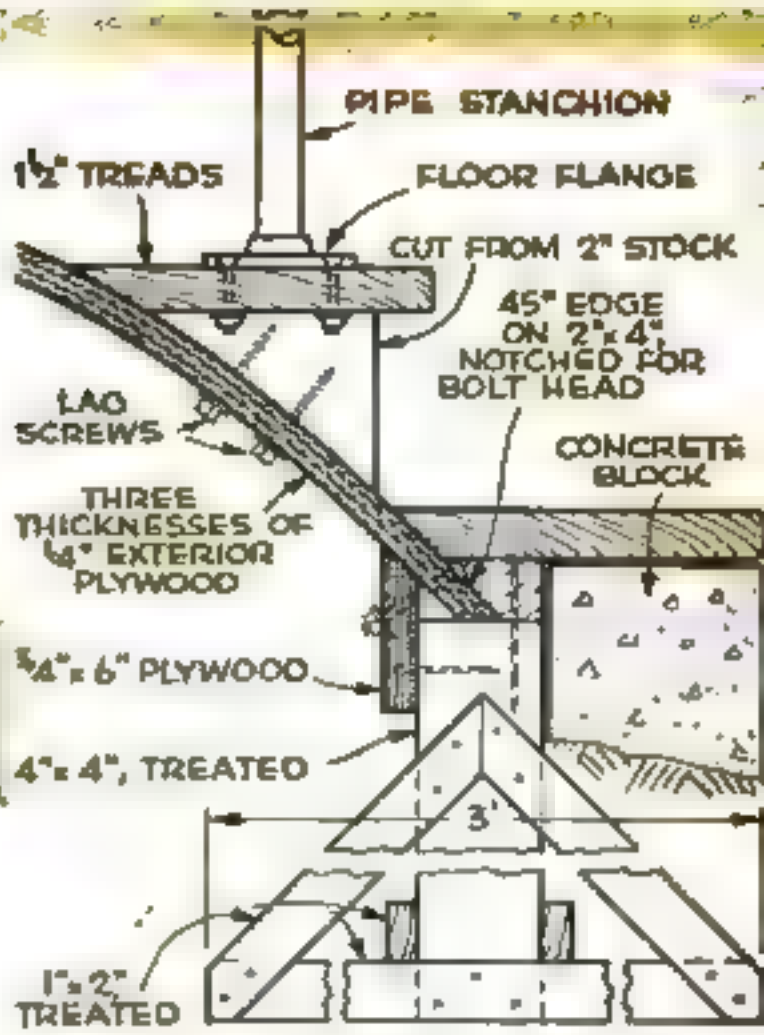
No brook or gully to cross? Even so, there are ways to use a small span as a landscaping feature

By Harry Walton

WHETHER it crosses a stream, a ravine, or a rock garden, a bridge transforms any setting. A little one, perhaps crossing a flower bed, may be just the thing to highlight a dull spot in your yard or garden. If a brook or gully divides the property, a foot bridge affords fuller use of your land.

Make it sturdy, for even a purely decorative bridge will attract children. Use No. 2 or better lumber, or, for maximum strength, Select Structural grade. Any wood in contact with the ground, or subject to soaking at high water, should be treated to make it water repellent.





As a garden ornament, an arch bridge is a favorite. Sink three treated posts, with crossbars nailed to them, for each anchorage. Across them spike a two-by-four ripped at 45 degrees along one edge. Saw the arch laminations to the desired width from 8' panels of exterior plywood or weatherproof hardboard. If 5/16" material is too stiff for the arch you want, use three ¾" sheets, as shown in the sketch.

Trim a little off the end of the inner laminations, and clamp all in contact their full length before drilling the holes for the lag screws that hold the step brackets. Use washers under the screws. Paint the exposed plywood edges.

Your Own Foot Bridge

If a piece has camber (a curve along its length), use it convex-side-up so that the load tends to straighten rather than increase the camber.

Big bridges or little, all are based on the same principles. A fallen tree bridging two banks was the earliest example of the beam, and a strictly utilitarian bridge (as at right) can be almost as simple. A plank laid flat across end supports will readily bend at the middle. But set on edge, it deflects much less under load. So if beams are wider than they are thick, place them edgewise to the load.

A square of four sticks with a single nail at each joint folds at a touch. But fasten three sticks that way and you can't

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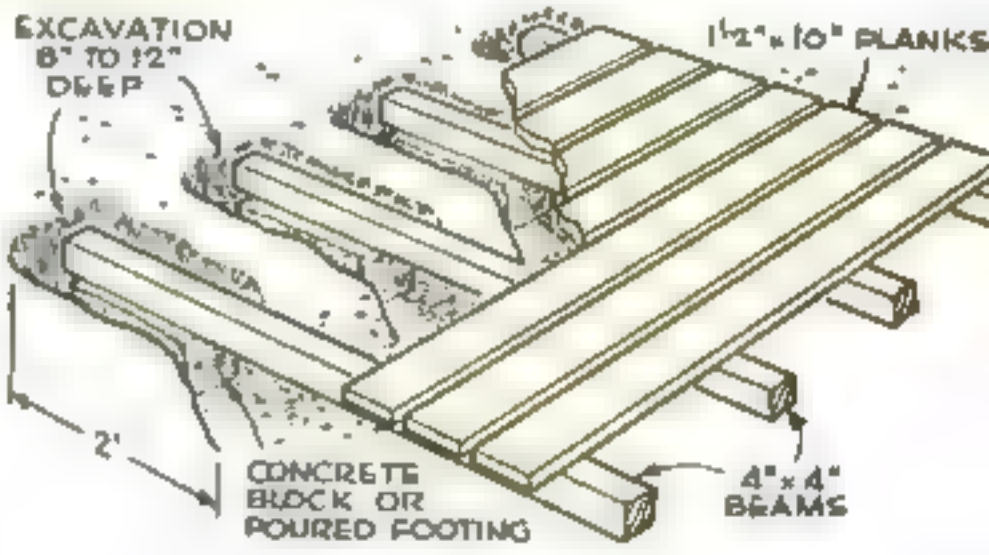


Simple but serviceable, this bridge spans a brook on the grounds of Aldo P. Biagiotti, Ridgefield, Conn. At a point where both banks were level, he dug four rectangular trenches 2' long in each and set in home-cast concrete blocks. Troweling on wet concrete, he laid 10'-long oak four-by-fours in this and leveled them. The wood was then creosoted, the trenches backfilled, and 10' floorboards, of oak two-by-eight, nailed 15" apart.

Flooding washed away planks laid across this stream, but a steel-conduit bridge has survived heavy weather. Frank Rowsome, Chappaqua, N. Y., cut truss members from ¾" and 1" thin-wall conduit and filed ends to make neat butt joints. Most were welded. An easier way is to braze [illegible] as bike frames or [illegible] a butane torch. Disks were set into open ends. The 30° end verticals extend into concrete blocks below. Floor consists of slats on two-by-threes. Ramps hook over the end crosspieces

change the resulting shape without breaking a side or a joint. This is the basis of the truss, an assembly of triangles between a top chord, or stringer, and a bottom one.

The classic arch translates a downward load into horizontal thrust against its anchorages or abutments. These must therefore resist shifting, besides supporting the weight. An arch of two or three laminations of plywood or hardboard is surprisingly strong.

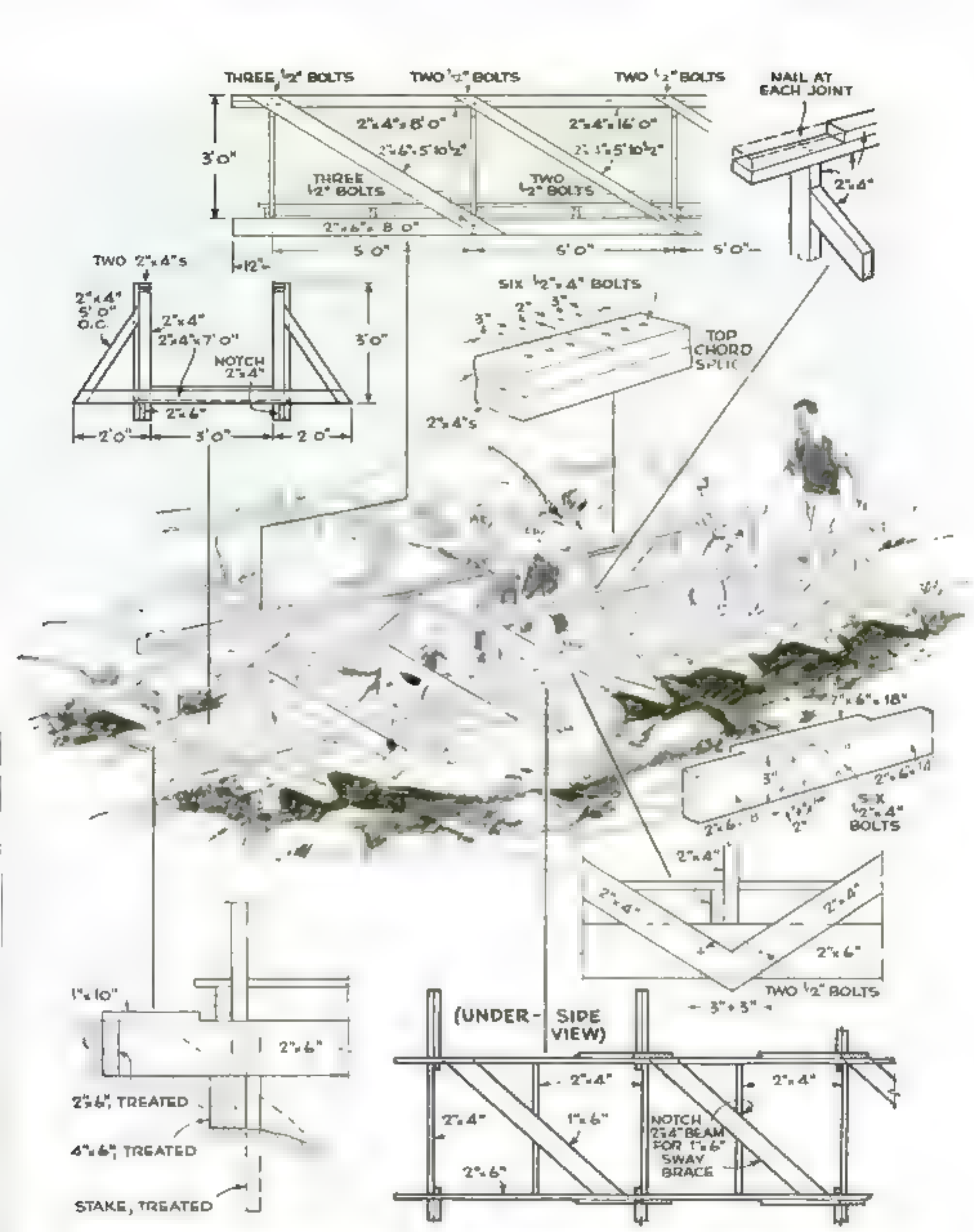
An inside-out equivalent of the steel I beam, the box beam can be homemade of stock lumber and plywood. Glueless, nailed beams of this kind were developed by the Douglas Fir Plywood Association as headers over two-car garage doors. Two light ones will support a 16' bridge.

Besides its own weight and the live load of traffic on it, a bridge must resist wind pressure and cornering forces that try to push it askew. Crosspieces, diagonal braces, and floorboards help resist these. If two braces cross, nail them together at the center, forming still smaller, more rigid triangles than the originals.

Where single lengths of lumber are not long enough, splices can be made with tie plates of the same stock and three well-spaced bolts on each side of the joint. Plan splices so that they do not come opposite each other.

For stressed joints, experts recommend extra-strength spirally grooved galvanized or aluminum nails. Cadmium- or zinc-plated bolts that won't rust keep joints tight longer.

Tongue-and-groove flooring laid up tightly adds cornering resistance to a bridge deck, but must be kept painted to avoid



Truss bridge above illustrates the correct building procedure for any of its type. Designed by Weyerhaeuser Company, Tacoma, Wash., for a span of 32' with 5' spacing between its vertical webs, it can be built in any smaller size. The top chord consists of two two-by-fours laid flat, splices in one being bridged by a continuous section of the other. Splices in the bottom chords, made with plates, are staggered so as not to be opposite one another. For shorter spans, you would use continuous lengths, without splices. Bolt the diagonal braces through the edges of both top-chord plates. Notch the bottoms of the webs to fit inside the bottom chords, and bolt securely through the webs, the chord, and the diagonal braces.

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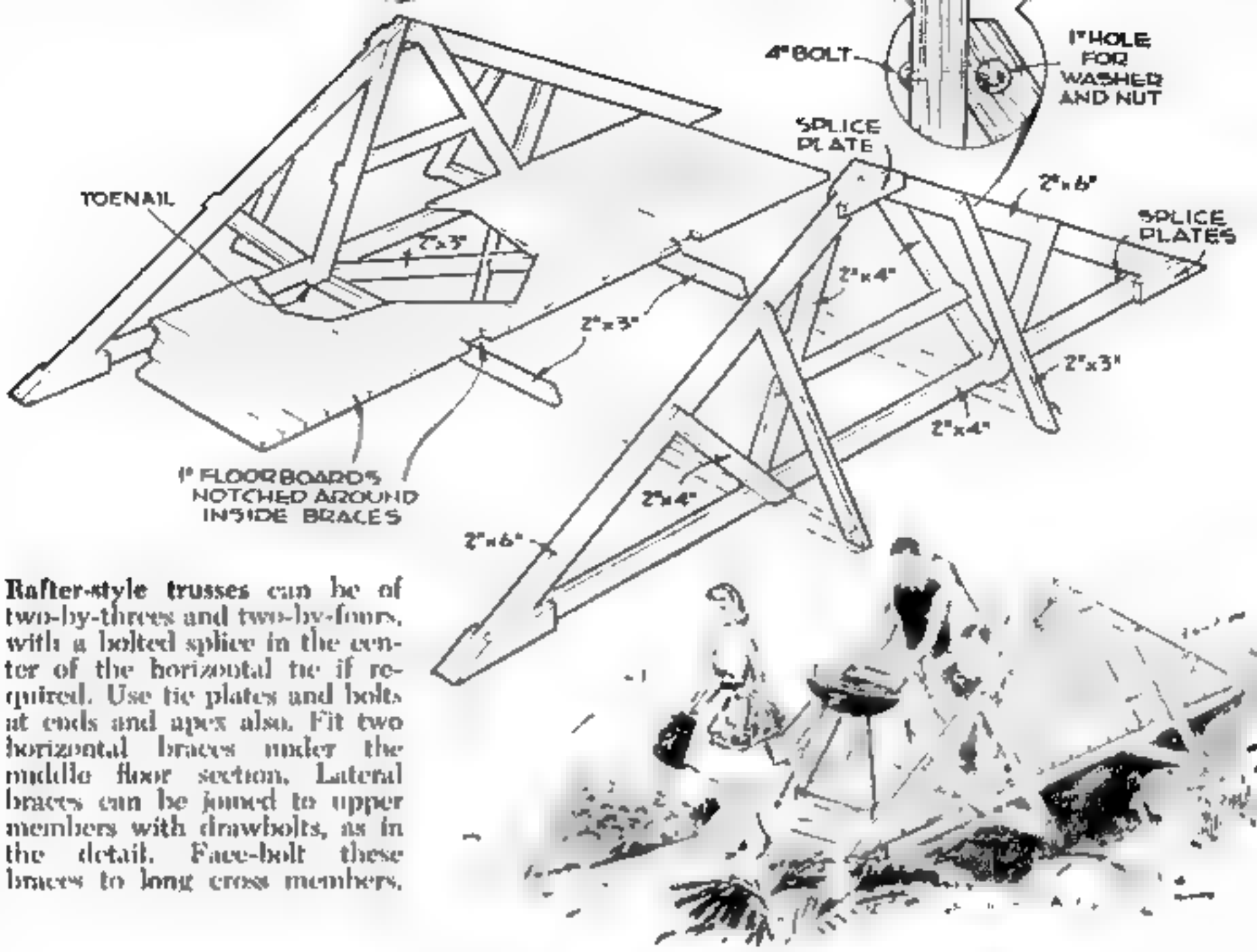
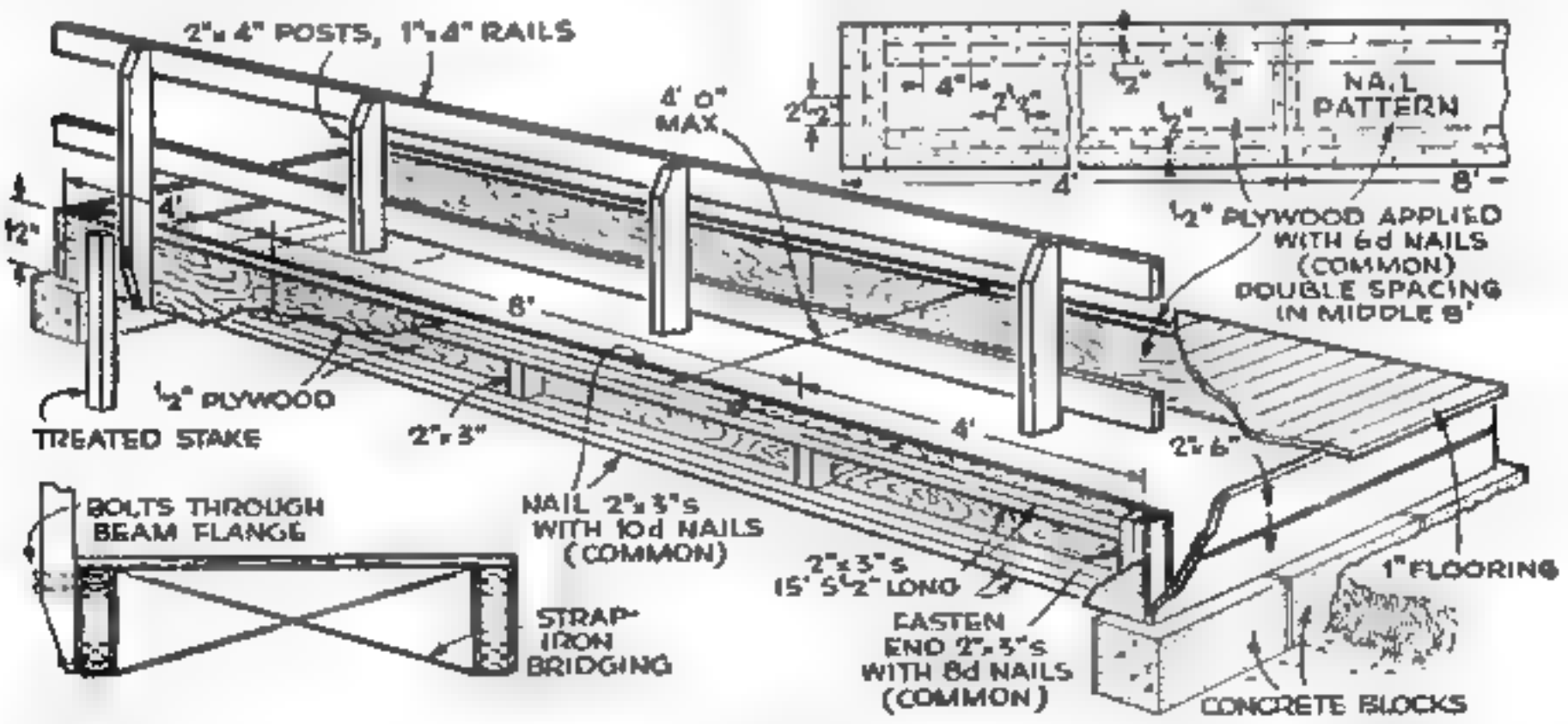


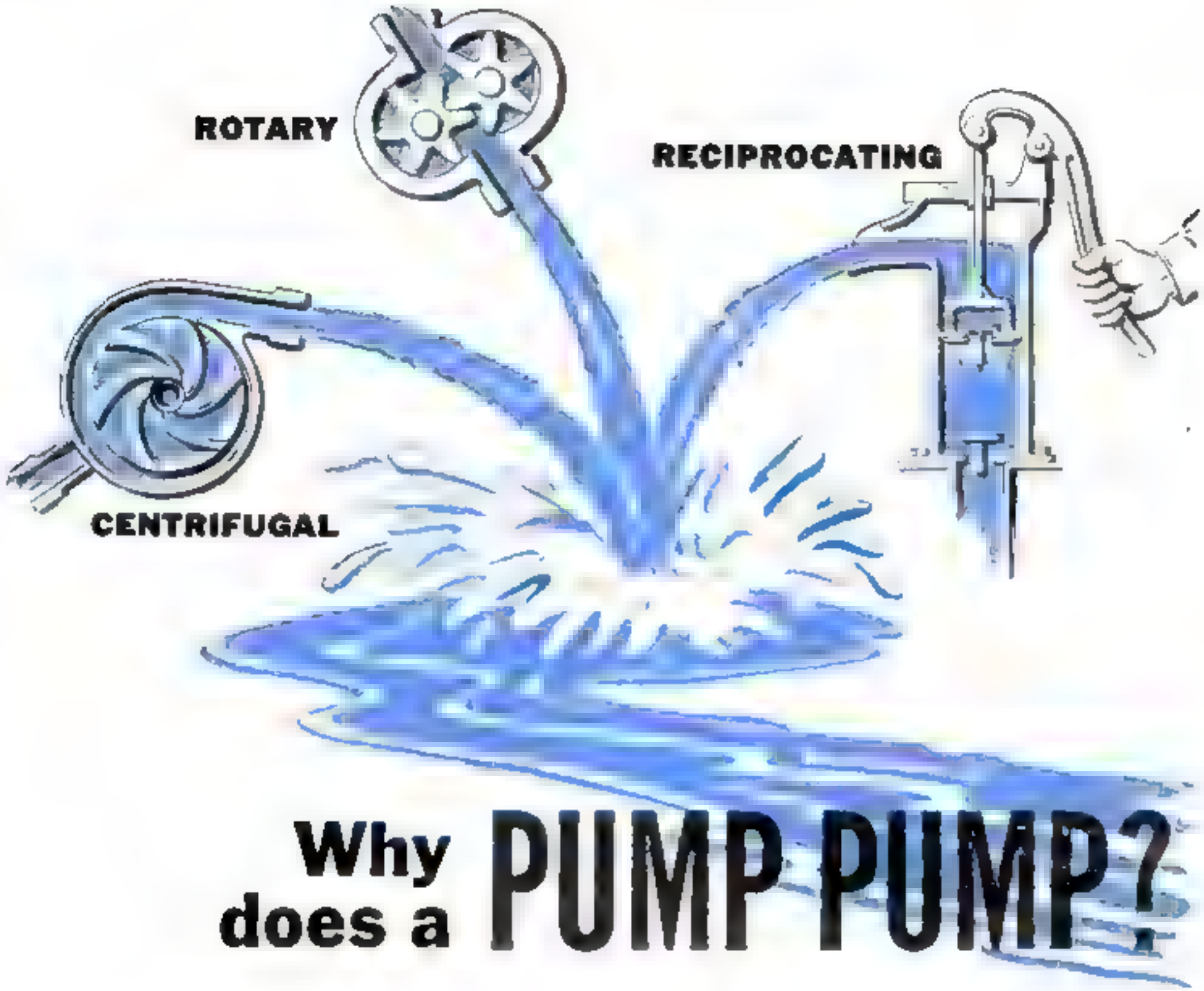
Rafter-style trusses can be of two-by-threes and two-by-fours, with a bolted splice in the center of the horizontal tie if required. Use tie plates and bolts at ends and apex also. Fit two horizontal braces under the middle floor section. Lateral braces can be joined to upper members with drawbolts, as in the detail. Face-bolt these braces to long cross members.

deterioration. Boards gap-spaced 1½" let water drain through and require less upkeep. They will bend less if set on edge, with spacers of ¾" exterior plywood between. A plywood floor may be painted, covered with mineral-surfaced roofing, or given a wearing surface of sand mixed with waterproof glue.

Stanchions for railings may be of pipe screwed into floor flanges, conduit bolted to the beams, or two-by-fours. The railing itself may be pipe or conduit, mounted in T fittings on the stanchions. Wood rails can be nailed or bolted on. Concrete-reinforcing bar or wire-rope railing may be strung through holes in the uprights ■ ■



Nailed box beams carry the load in this 16' bridge. Cut flange members 15' 5½" long, nail on doubled end stiffeners and set in three more stiffeners, 4' apart. Cut six 12"-wide plywood panels 8' long, and four 4' long. Use two long panels on one side of each beam and a long and two short ones on the other. Stagger all joints and back up each one by a stiffener. Nail metal strap braces to top and bottom of the beam flanges and two-by-sixes across both ends. Fasten the rail stanchions with bolts through the beam flanges.



Why does a PUMP PUMP?

Three basic principles, cleverly varied, produce a fascinating array of modern liquid-movers

By Robert Gorman

PUMPS rank second only to electric motors as the world's most widely used machines. In a typical home today are from four to eight pumps, in a typical new car from three to seven. Without their quiet efficiency, almost nothing we depend on would work right.

Fully half the comforts and conveniences of modern life are due, in some measure, to the inventive genius of an unknown Bostonian. Back in 1818 he put a set of revolving vanes inside a casing and invented a centrifugal pump—the most versatile liquid-mover of all time. It was the forerunner of millions of present day devices that move or add pressure to anything that flows.

Yet this remarkable development attracted so little notice in its own time that the inventor's name hasn't even been recorded. The reason? Centrifugal pumps make use of the same natural force that causes a weight to fly outward when you whirl it at the end of a string. But to bring this force into play, the pump must turn at high speed. It was therefore the best part of a century before gasoline and electric power made it practical to move large amounts of liquid by centrifugal force.

In the meantime, thirsty citizens had to rely on two equally natural—but less speed-dependent—principles: scoop and suction. The first moves liquid by the direct push of a solid surface. The second does it indirectly through the lift of atmospheric pressure.

In past times, direct displacement was achieved most commonly by the old oaken bucket. While this is not a true pump, it is related, through the paddle wheel and continuous-bucket chain, to a wide variety of

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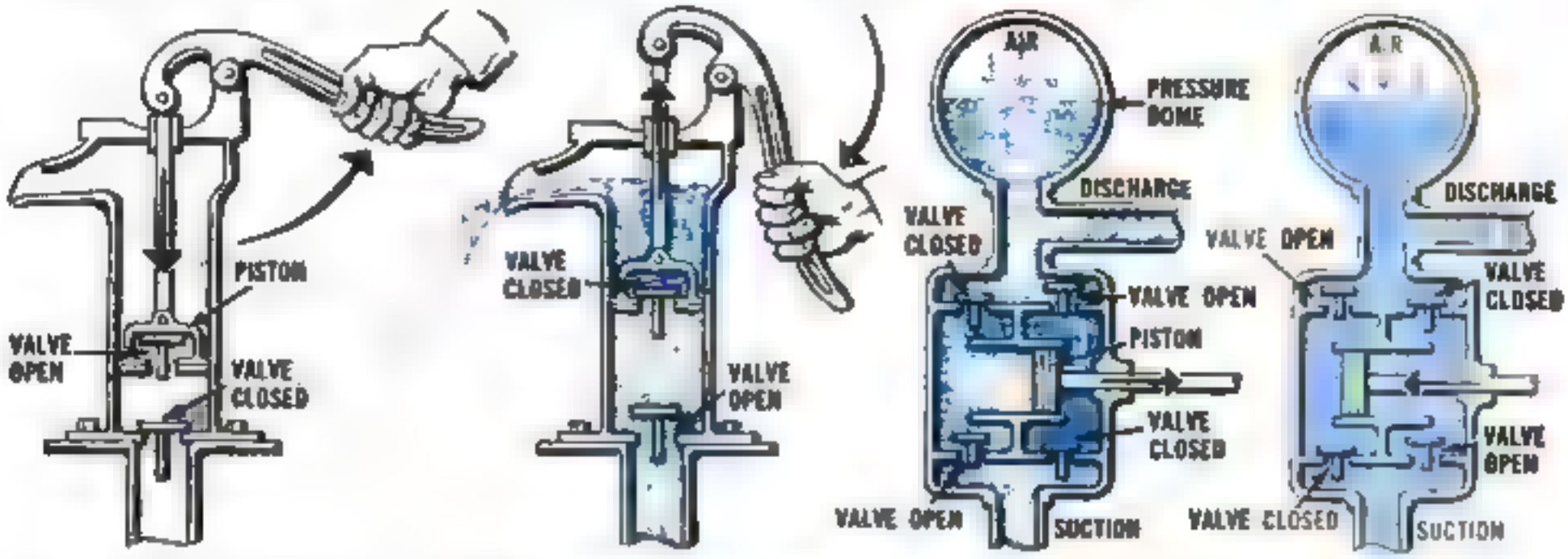
Single or double action? It makes a difference in a well pump



The old hand pump is a familiar example of the single-acting lift type. Its piston moves water only on the upstroke, creating suction that pulls up new water for the next upstroke. In more modern double-acting force pump at right, the piston moves sideways. Two sets of valves permit it to pump on both strokes, providing a more continuous flow. Pressure dome at top acts as a reservoir, smoothing the flow still more. Because the piston pushes, instead of just lifting, it can force liquids above its own height, and is thus called a force pump.

rotary pumps that alternately trap and discharge volumes of liquid. Modern rotary pumps trace their ancestry back at least 22 centuries to the screw conveyor credited to the great Greek scientist, Archimedes.

The old village pump. The most familiar example of an atmospheric-pressure device (next to the soda straw) is the reciprocating, hand-cranked, wellhead pump. Since the beginning of modern history it has been used to whoosh water into millions of village squares, farmyards, and kitchens. It is still going strong

The simplest suction, or lift, pump works by forcing air out the top of a well pipe. The higher pressure of outside atmosphere then pushes water up the pipe to fill the vacuum. Air-pressure pumps, using valved leather plungers inside hollow logs, were the first in common use. They were, in fact, the first machines to be called "pumps": the word comes from the echoing sound made by their plopping plungers

These three basic movers—scoop, suction, and centrifugal force—are the backbone of all modern pumps. If they are sometimes hard to recognize, it's because they have been combined in thousands of ingenious ways. Most commonly, pumps are classified as rotary, reciprocating, and centrifugal—terms that refer to their actual type of mechanism. You'll also find subclasses, such as paddle, roller, and gear. Still other words, such as submersible and multistage, may describe different aspects of the same machine.

But while their names may seem complicated, most pumps are, in fact, elegantly simple. Pump designers work with a basic "kit" that contains a few basic parts that can be arranged to meet every conceivable flow need.

The reciprocating pump. This is usually a vertical well pipe with a cylinder at the top. A valved, "single-acting" piston inside the cylinder pulls up a little gob of water on each upstroke. The suction created by the lifted water then pulls up a corresponding

In this deep-well jet, a high-velocity stream is shot down to speed up the upward flow. A venturi then slows the flow, exchanging its speed for more pressure. This lets the pump lift more than the normal 28 feet—as much as 200 feet

amount from the well, ready for the next piston stroke. Because the action is intermittent, the water comes out in spurts.

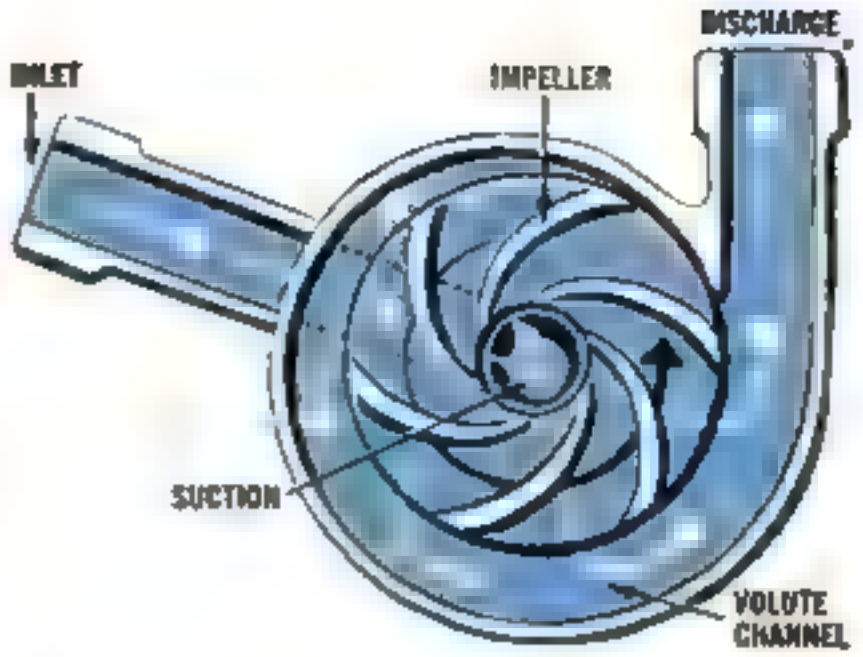
To smooth the flow, however, you need only turn the cylinder horizontally and move the piston from side to side instead of up and down. As the diagram shows, this "double-acting" piston moves water on both strokes and therefore delivers a reasonably continuous stream.

In either version, the suction pump has to rely on nature's gift of atmospheric pressure, which is limited. Air pressure can only lift a liquid to a height where the weight of the liquid itself begins to exceed the force of air acting on it.

A column of water weighs .433 pounds per square inch for each foot of height. Since atmospheric pressure is 14.7 pounds per square inch, the maximum height water can be lifted by atmospheric pressure is 34 feet. This is only theoretical, too—the practical maximum is actually 25 to 28 feet. In the case of a heavy liquid like mercury, the maximum height is 30 inches—our familiar mercury barometer.

For higher lifts you must start rearranging the parts. In the deep-well version of the reciprocating pump, the piston is placed at the bottom of the well and driven by a long rod from the top. In this case, the piston actually hoists each gob of water up the well pipe, instead of relying on air pressure to lift it up. Powerful pumps of this type are used to bring oil up from wells hundreds of feet deep.

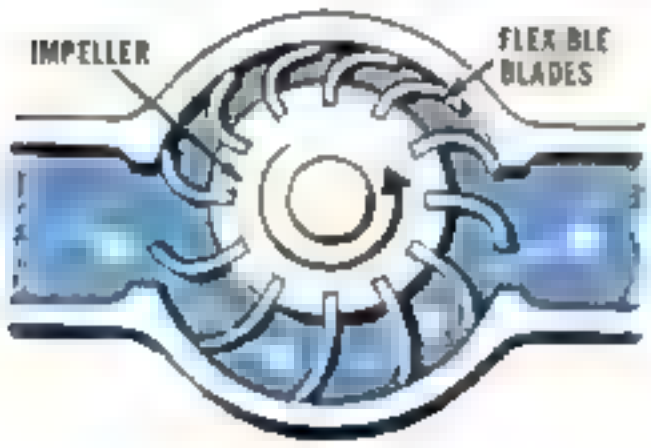
For deep wells, a jet pump. Modern country dwellers often rely on pumps that

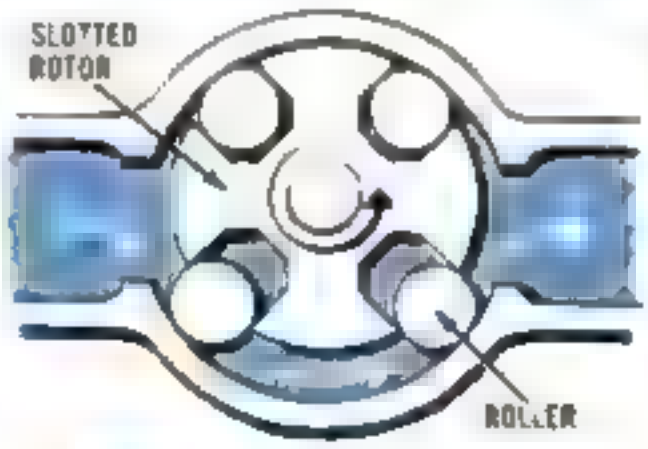


Why a centrifugal must convert high speed into usable pressure

Centrifugal pump looks something like the rotaries below, but works on a different principle. Its spinning vanes sling liquid outward, speeding it up but imparting no pressure to it. To increase pressure, pump above uses a gradually widening discharge chute, called a volute. This slows the flow like a venturi, converting some of its speed into pressure.

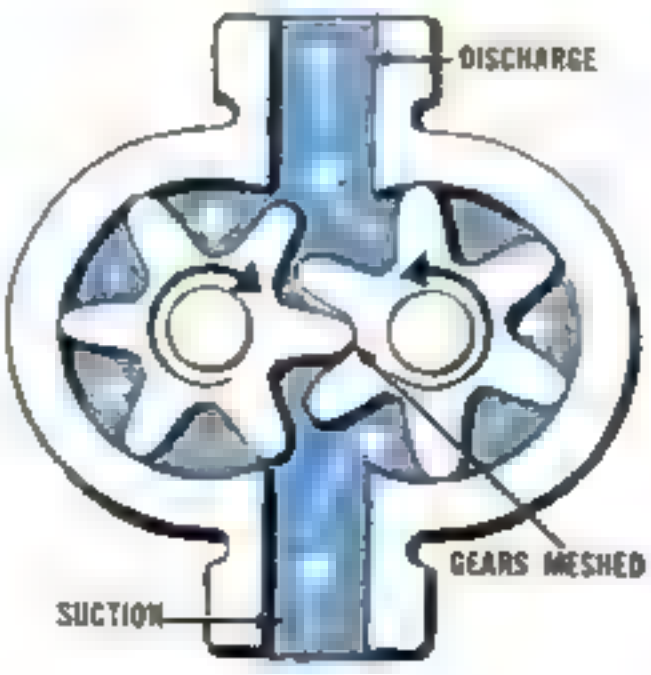
Rotary pumps use ingenious tricks to lick the backflow problem

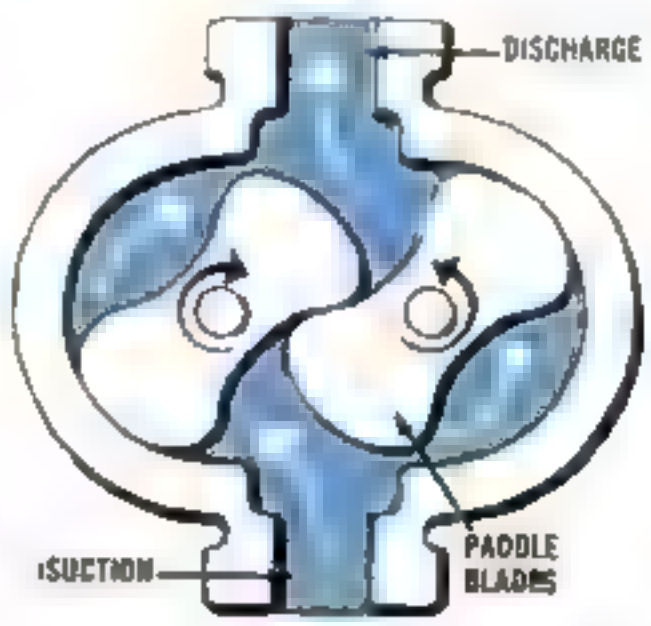




Off-center impellers in these pumps create a wider passage on the forward stroke than on the return, making it hard for liquid to be scooped backward. Flexible blades at far left and sliding rollers at near left expand and contract as they rotate

No wasteful backflow gets past the highly efficient gear pump at near right. As the gear teeth sweep liquid forward around the outside of the housing, they mesh at the center to block any backward leakage. Paddle-blade pump at far right works in a similar way. Its dogbone-shaped blades, always in mesh, scoop liquid forward, but overlap to prevent its return.





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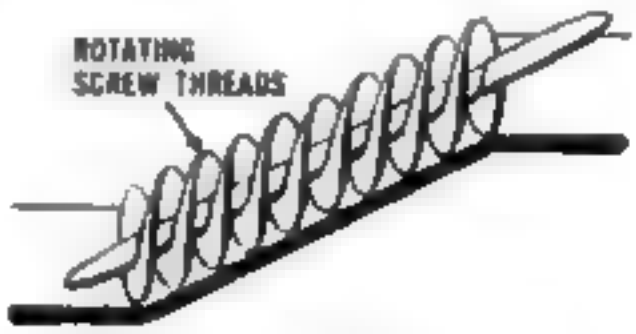
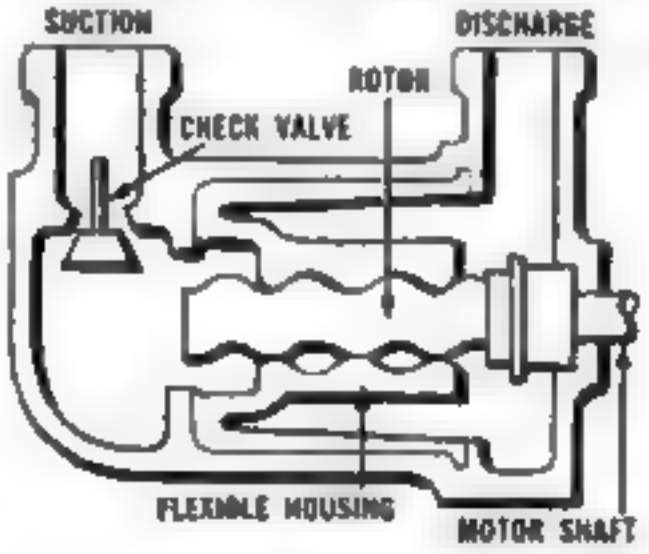
deliver water from practically any depth. The one device most responsible for making this possible isn't really a pump at all. The deep-well "jet" or "ejector" is actually a pump attachment. It increases a pump's suction lift beyond the normal 28-foot limit of unaided atmospheric pressure.

In operation, a jet attachment taps off part of a pump's high-pressure discharge and shoots it back down the well through a "drive" pipe that parallels the intake pipe. Near their lower ends the pipes are joined by a nozzle that squirts the high-velocity "drive water" up the intake. The drive water speeds up the main flow and therefore lowers pressure in the pipe. More water then rushes up from the well to fill the partial vacuum.

Having tricked atmospheric pressure into supplying this extra lift, the pump now places a venturi tube in the path of the combined flow. The venturi is a restriction in the pipe that narrows sharply to a small opening, then widens out gradually to a large passage on the opposite side. The high-velocity water squeezing through the narrow opening suddenly slows down as it spreads out into the larger passage. This reduction in speed is transformed into a boost in pressure which is what you really want. This increased pressure then enables the pump's normal suction to lift water much higher—up to 200 or more feet.



The old: Archimedes' screw, devised by the famous Greek scientist around 200 B.C., is the earliest-known ancestor of today's efficient rotary pumps. It used a rotating spiral blade to push water uphill. Below: its modern counterpart.



The new: Spiral rotor in this helical pump pushes liquid along in "pockets" formed by its blades. Pockets move only forward so there's no backflow.

At the top of the well, part of the flow is diverted for use, while the rest is shot down the drive pipe again to bring up new water. The jet's simple design accounts for its popularity. It has no moving parts to get out of whack, isn't damaged by sand or sediment, and is small enough to fit in drilled wells.

Submersibles go even deeper. When still greater lifts are required, the answer is to reshuffle the building blocks once more. The pump is sunk to the base of the well where it can push rather than pull. Submersible pumps (also called submergibles) are said to have been developed during World War I for draining trenches and mine shafts. They were later adapted to oil wells and have operated at depths up to 12,000 feet. But it wasn't until after World War II that they really came into wide use, some of them even by home owners.

What makes submersibles "modern" is not so much their design innovations as their machinery—the compact, foolproof, permanently lubricated electric motors that work under water. The motors generally drive a high-speed centrifugal pump to do the actual water moving.

How a centrifugal works. It has only two basic parts—a circular housing and a vaned impeller blade with a hole, or "eye," at the center that spins inside it. As liquid enters the eye, it is accelerated by the vanes and hurled outward against the housing, which deflects it out a discharge nozzle.

The impeller is the pump's only moving part. It is equally at home emptying laundry tubs or feeding multimillion-gallon water supplies. Since the spinning impeller imparts centrifugal force to anything that enters the eye, the pump isn't greatly troubled by sticky or sediment-filled liquids.

It does have one drawback: The speed and pressure of any stream are like the opposite ends of a seesaw. Anything that accelerates the stream lowers its pressure—and vice versa.

So pump designers usually try to work a trade. One popular type of centrifugal pump has a spiral discharge channel, called a volute, that gets wider toward the outlet. The expanding channel gradually slows the water on the way out and thereby gives it a pressure boost, just as the venturi does in a deep-well jet.

But the most effective way of increasing

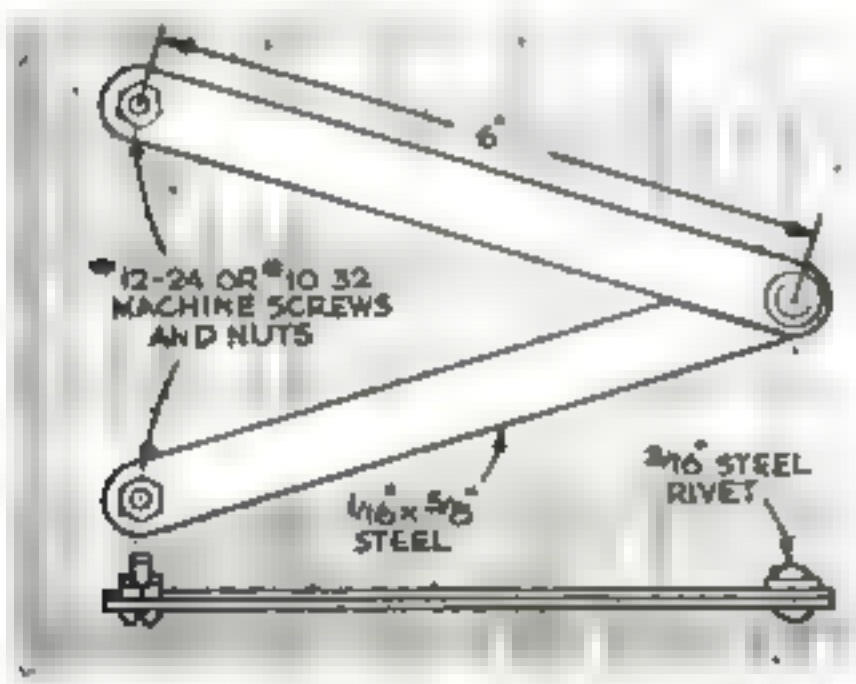
[*Continued on page 179*]

Short Cuts and Tips FROM READERS

Slate counter top is a blackboard, too

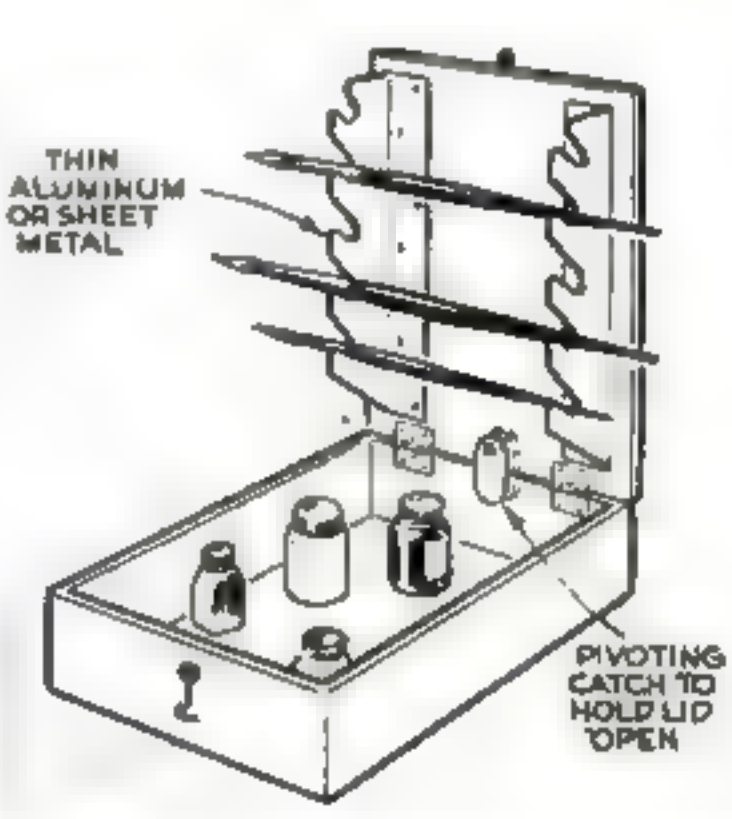
Remodeling your kitchen to include a desk counter? Try a slab of real slate for the whole surface (left) or for an insert. It'll be handy for jotting down family reminders and telephone messages, yet it takes no wall space and wipes clean.

▶▶▶You'll have a variety of inexpensive grit surfaces if you make your own grinding wheel. Scribe a circle on heavy sole leather, cut it out and clamp it to a board to bore the arbor hole. Then cut two disks of emery paper—coarse and fine—and mount them back-to-back on the arbor with the leather between. To avoid dulling edge tools, I cut my emery with a cold chisel on an iron block (the arbor hole can be square). Spinning, the leather becomes as true and stiff as a steel disk. When the paper dulls, it's easy to replace—it's not glued on.—*F. L. Trudeau, Tweed, Ontario.*



Make an adjustable spanner wrench

Here's a spanner wrench that can be adjusted to fit any combination of sizes and spacing of holes or slots. The pivoted arms permit spacing adjustment, and the pins are removable so you can insert the ones that suit the size of the holes or slots in the work at hand. You can, of course, alter the size of the wrench to suit your own range of work. Before peening the rivet, place a washer on it to avoid locking the arms. Ordinary machine screws can serve as pins if you happen to have the correct size and length. Harder pins can be turned or ground from self-tapping screws.—*Archibald Black, Stafford Springs, Conn*



Modelmaker's paint box has brush rack

Want a handy rack for brushes—on your paint box? You start with a hinged-lid wooden box large enough to hold the paints, solvents, brushes, and other material used in finishing models. Cut the two brackets simultaneously from sheet aluminum, to be sure the notches conform. Bend each to form a mounting flange. Space them at least 4" apart, but recessed from the edge enough to permit the lid to close. A pivoting catch braces it open. —*H. A. Fluchere, Irvington-on-Hudson, N.Y.*

Safety Tray for

Is this play table better than seat belts for young passengers? Yes, says the inventor—and tells how to make your own

By J. F. Liston

A BORED child in a car is a highway hazard. Stashed away in the back seat with nothing to do, he may hang out the window, impulsively open a door, or stand behind the front seat, distracting the driver.

I speak from experience: I'm the father of five. On long hauls I used to cope with every type of back-seat problem. Even on those rare occasions when all five sat quietly, I was always fearful they'd be toppled by an abrupt swerve or stop.

Two years ago, I designed a car safety accessory to solve these problems. It's a removable table top, hooked between the rear doors. It provides play space to keep my brood happy, it keeps them seated, safely locked in; and the padded rear edge cushions them against sudden impact.

The seat-belt campaign has made family drivers more safety conscious. However, there's still a psychological barrier: When you strap a seat belt around yourself or your kids, you're anticipating an accident. Many of us prefer to ignore such unpleasant speculations. That's one reason I say my safety tray is superior to seat belts: Its play application chases this stigma. The table top is ideal for card games, puzzles, writing, or coloring. Neither you nor the children have to think of it as a safety device.

Yet you can travel with confidence that the kids are protected. And for that purpose, my tray is more practical than seat belts—you can't very well keep three or more youngsters tied down, even if your car has belt anchorages for the back seat. My idea is fully patented, but the tray is not yet in commercial production. So, in the interest of child safety (and back-seat fun), I'm waiving my rights for those who want to fit their own cars with such a homemade accessory.

The tray is easy to lift out when you don't need it. A quarter-turn of the handle withdraws the pins that lock the hooks over door-mounted pulls. This locking is essential. In a collision, occupants of a car are not usually thrown straight ahead, but at an upward angle of about 45 degrees. Thus there might be considerable force to lift the rear edge of the tray. I designed the hooks to prevent this. If you can get at the inside of your door, use nuts on the bolts that secure the pulls. Otherwise, use the largest sheet-metal screws the flanges will take. You may need a spacer behind the pull so that the strap will clear the window sill.

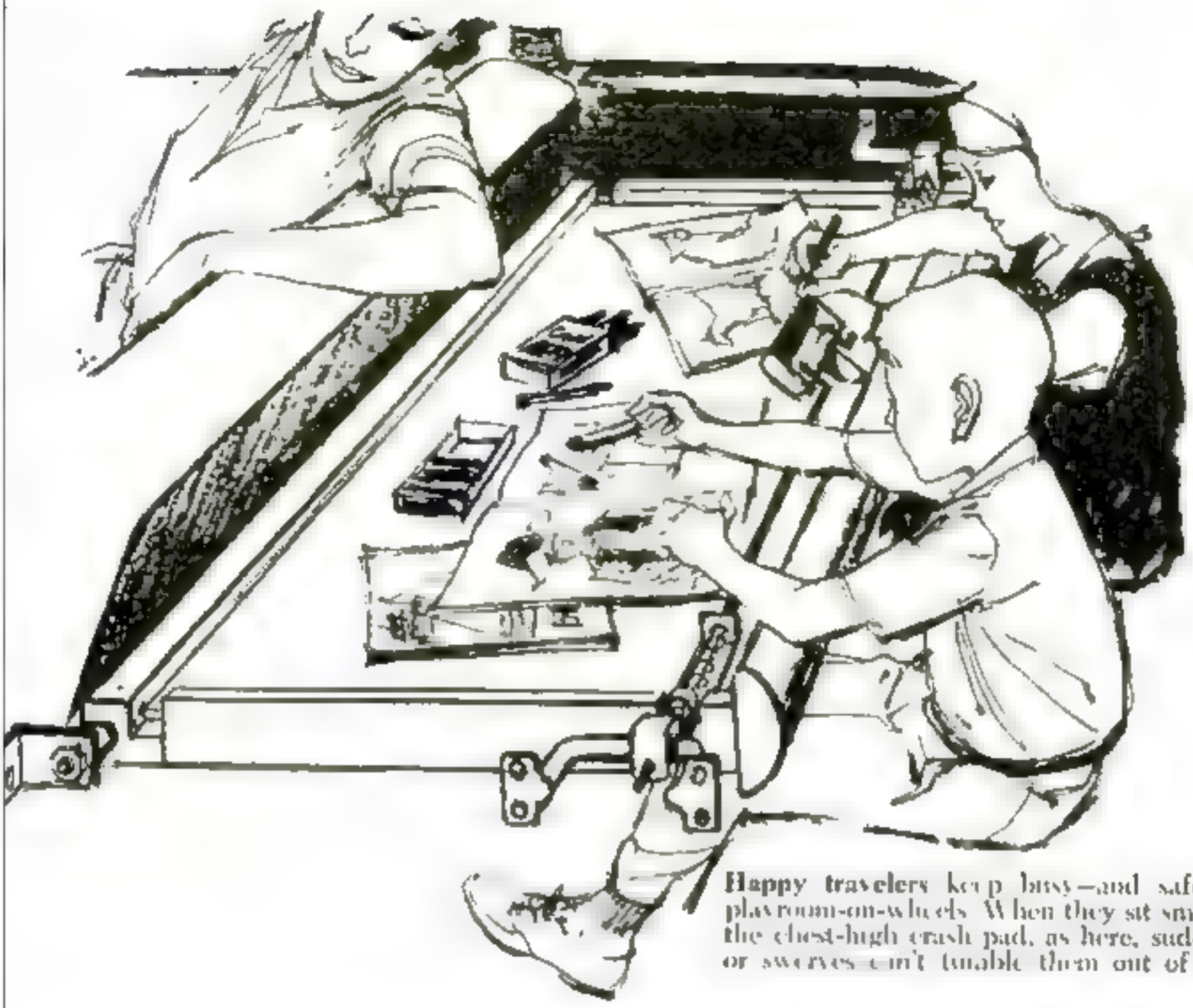
The easiest way to attach each bicycle spoke to the lock pin it drives is to drill the rod and solder in a spoke tip. The collars on the rod serve a double purpose. They provide a shoulder for the sprung to push against, and they limit the outward travel of the rods. The springs urge the lock pins in place. Mine are screen-door springs, stretched and cut to size. For maximum security, you could install springs strong enough to prevent a child from turning the handle.

You'll need two brackets for mounting the pivot rod between the center posts of the car. To position this rod, push the front seat back as far as you ever use it, then design angles that will place the rod where it's needed. Bolt the angles to the posts, after making sure the door will close on them. This clamping action strengthens the joint. For my pivot, I used ½" pipe with a ½" rod (several inches longer and threaded on each end) inserted through it.

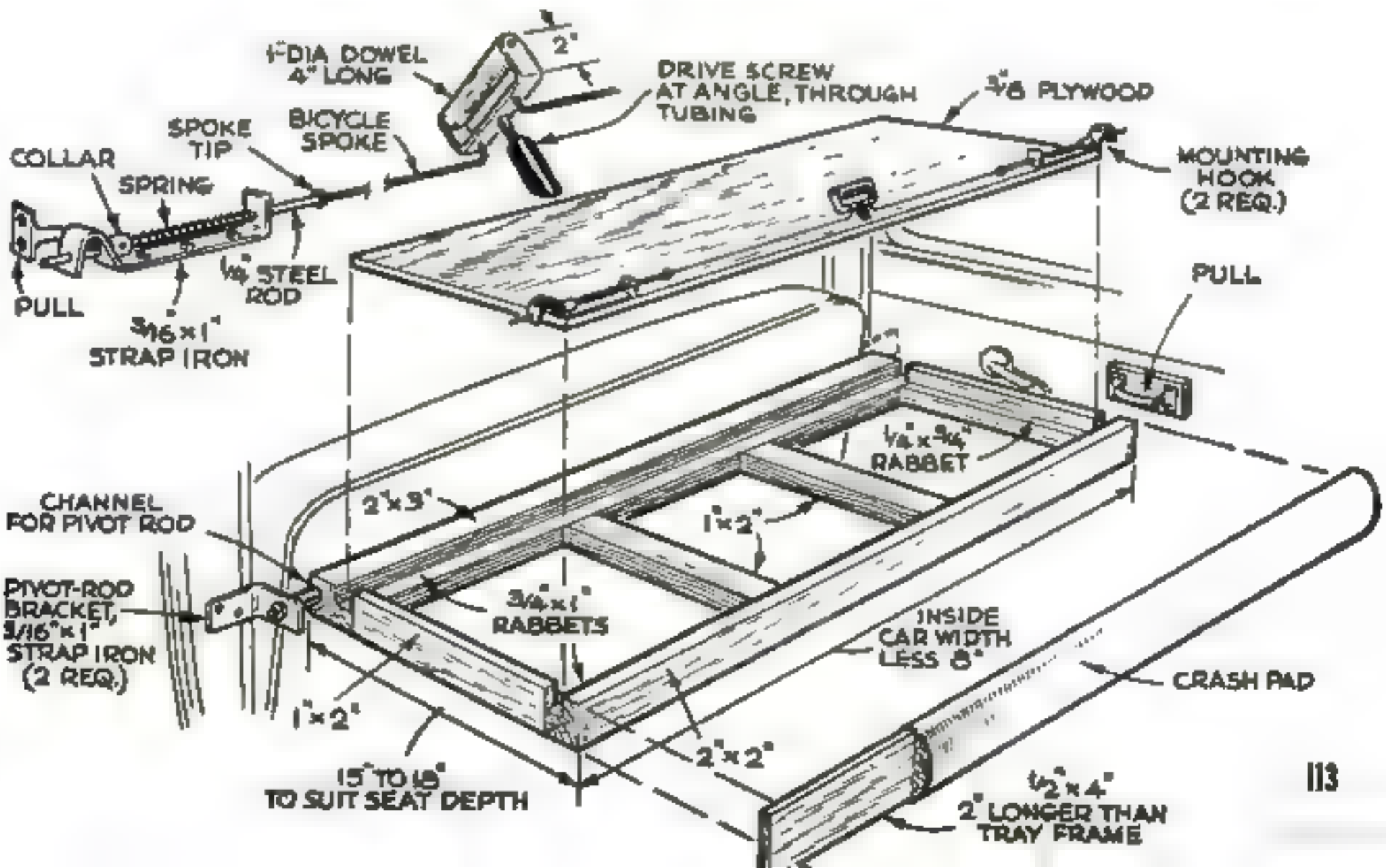
The depth of the tray should bring the crash pad as close to the passengers as comfort permits. My pad is simply a slab of balsa wood, shaped and glued in place. It's an excellent shock absorber since it crushes to absorb impact without rebound.

The plywood panel is set into rabbets deep enough to provide a rim all around that keeps pencils and crayons from rolling off. If your kids have a favorite board game, you can glue it to the table top and drill a hole at each playing position, so they can use jiggle-proof pegs.

Back-Seat Fun



Happy travelers keep busy—and safe—in this playroom-on-wheels. When they sit snug behind the chest-high crash pad, as here, sudden stops or swerves can't tumble them out of the seat.



PS BOATING

Big Revolution in Boat Shapes

...makes 'em faster, smoother, more stable

By George Daniels

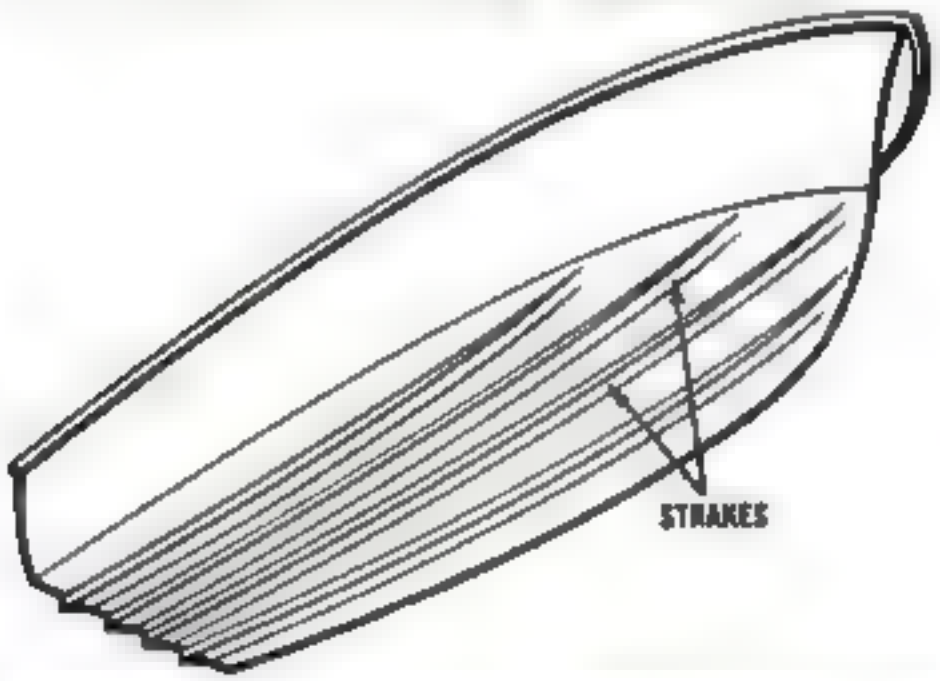
AT 10:36 on the morning of May 2, a little open runabout flashed across the finish line of the Miami-Nassau Powerboat Race in the fastest time ever clocked. To astonished spectators, it looked, at first glance, like an ordinary V-bottom hull, traditionally an easy-riding, docile performer, but no speed demon. Yet, powered by a pair of 280-hp. MerCruiser outdrives, it had beaten boats equipped with up to 1,000 hp., covering the 180 miles of open sea at better than 50 m.p.h.

It wasn't the first time, either. For the Bertram Yacht Co., it was the third year in a row that their victorious V bottom, designed by naval architect C. Raymond Hunt, had walked off with top honors in the annual race. A closer look shows why. Formed into the deep V are a series of stepped planing surfaces that lift the hull

CONTINUED

Look what

Record-breaking winner of recent Miami-Nassau race looks like an ordinary deep-riding V hull until you see the underside. The secret: Longitudinal steps, called strakes, run full length of hull to lift it high in the water. This cuts drag, permits 50-m.p.h. speeds. Note in photo below how the deep V shape is carried all the way back to the stern on a similar Bertram design.

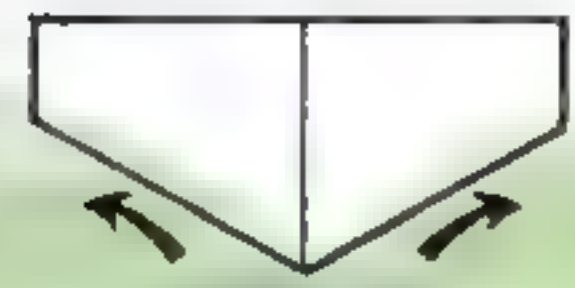


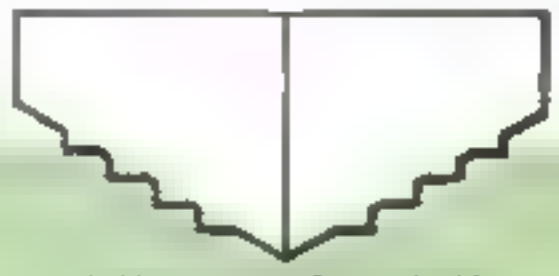
Modified V hull of this sleek Flying Scott flattens to a long planing area designed to eliminate the porpoising of Vee's gutters. Like many hulls, its rounded bottom turns so perfectly, says Scott, that a glass of water on the deck won't spill a single drop

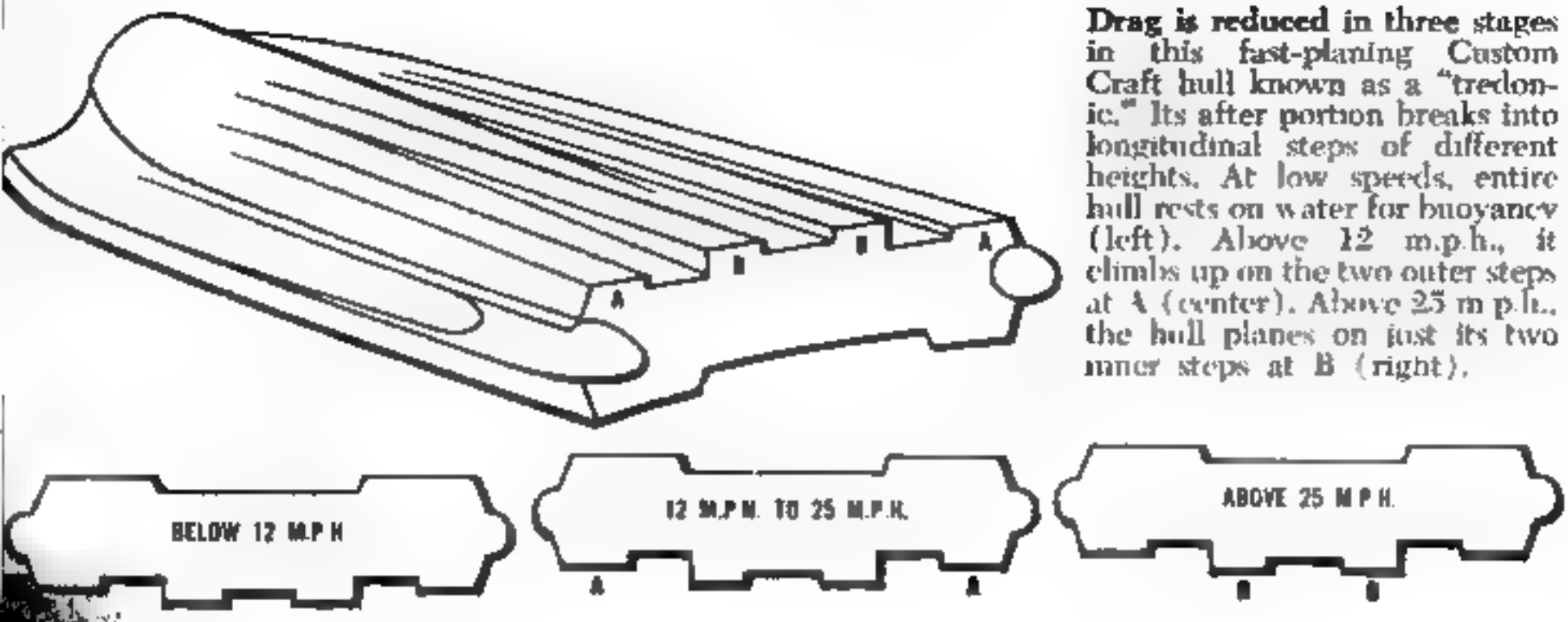
they've done to the old V bottom

Conventional V hull rides deep in the water wastes speed and power pushing through it

New Bertram hull planes on stepped ridges, rises higher as speed increases to reduce friction







Drag is reduced in three stages in this fast-planing Custom Craft hull known as a "tredonic." Its after portion breaks into longitudinal steps of different heights. At low speeds, entire hull rests on water for buoyancy (left). Above 12 m.p.h., it climbs up on the two outer steps at A (center). Above 25 m.p.h., the hull planes on just its two inner steps at B (right).

higher the faster it goes. This sheds drag, but retains the V bottom's inherent stability that two years before, had brought another winning Bertram hull safely through the roughest water ever encountered in a Miami-Nassau race.

This is only one example of a sudden and startling revolution in hull shapes, brought on by the current boom in pleasure boating. After building boats essentially the same way for 2,000 years, designers are now scurrying to meet needs that never existed before. Some of their designs are like the Bertram hull, patient modifications of classic principles; others are about as far out as you can get.

Behind the revolution is the fact that the chrome-plated, plush-seated motorist-turned-boatman expects to ride on water the way he does on four wheels. He wants superhighway speed and limousine comfort at the same time. He also wants a hull that's as rock-steady as the family sedan, even with all hands perched on one gunwale.

On water, this is a tricky problem. You can get either speed or smoothness fairly easily, getting both at the same time is tough. The flat planing hull is fast, but teeth-jarring on the rider; the deep-riding V smooths out rough water, but wastes a lot of speed and power doing it.

Designers have thus had to work out intricate compromises to provide the best of both. To do it, they've turned to water-testing models—and in many cases full-size hulls—in the same way that aircraft designers test airplane shapes in a wind tunnel. At marine laboratories like those of Stevens Institute in Hoboken, N. J., and Webb Institute in Glenn Cove, N. Y., accurate replicas of new designs are first tried out in tanks up to 300 feet long. Electronic instruments, measuring every motion, can tell exactly what miles per hour will cost in comfort—or vice versa.

To a great extent, the Miami-Nassau race was actually won in the tank at Stevens where the Bertram design was first proved effective. The new America's Cup contender, the Netertiti, was also tested at Stevens, where it was found that added hull length would increase speed. Significantly, the boat's designers willingly went along with the findings even though, under race rules, the greater length meant giving up some vital sail area.

Boats that ride like cars. In addition to the traditional V bottom, three other hull shapes are being modified, some radically, to meet modern needs: the catamaran, cathedral bottom, and three-pointer.

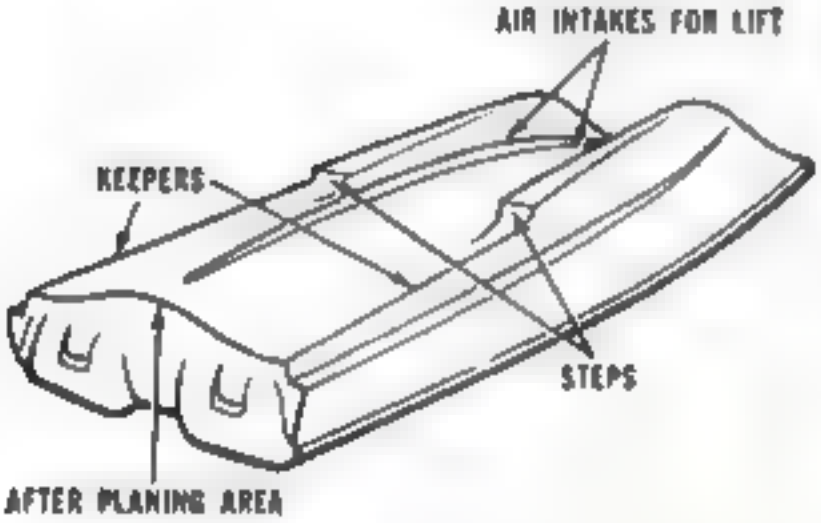
All have the wide-track stance of a road-hugging car, making them dock-steady even under poorly balanced loads. Skip off a wave top and you land level and straight. Run fast through a chop and you scarcely feel it. Beached, you're settled as firm and flat as a front porch. Most of the newer designs are also squared off like a car, giving you about 25 percent more usable space, compared to what's normally lost in a pointed bow.

Newest wrinkle: multiple hulls. The catamaran actually rides on a pair of pontoons that raise the interconnecting bottom area well above the water, eliminating friction and wave-smack. At planing speeds, the new designs pick up added lift from the cushion of air under the central unwetted bottom area—the same cushion that gives a low-wing monoplane a quicker takeoff.

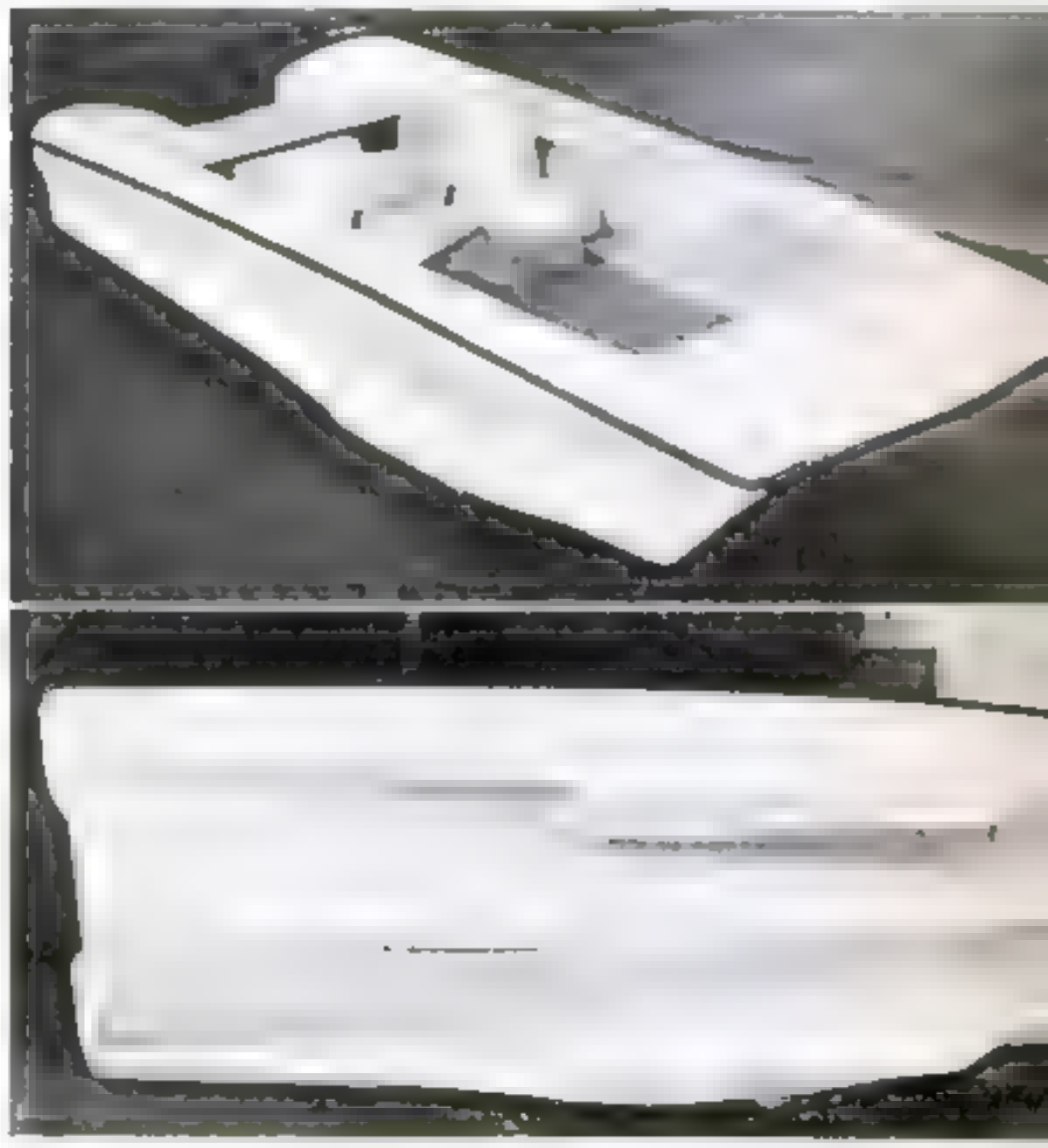
CONTINUED

Why twin pontoons make a catamaran both fast and stable

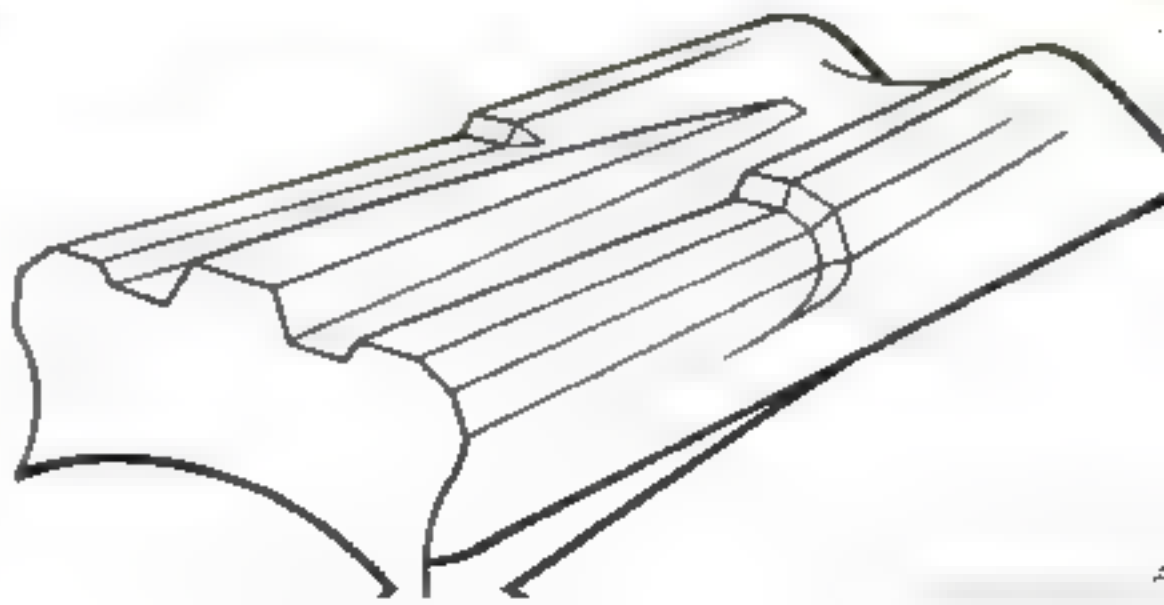
Wide-spaced pontoons, similar to a wide-track car (left), keep a cat level even when you sit on a gunwale. Air trapped between pontoons lifts hull to boost speed. To avoid turbulence at center of stern, many cats straddle it with dual engines, as on this Power Cat.



Three-point catamaran has pontoons dropped off at midpoint of hull, providing two steps. Hull planes on these steps and on center hump at the stern. Downward-curving lips at the sides, called keepers, trap air under the hull to give extra lift. The centered hull ridge is designed to add smoothness and stability in rough water. Note the square bow and short foredeck to provide spacious cockpit area in this sleek Custom Craft design.



Four-point catamaran, also by Custom Craft, is similar to two-step design above except that after portion has humped surfaces repeated at sides. Hull planes on these and forward steps, making it an unusual four-pointer. Added center hump at stern eliminates turbulence that an open tunnel would cause, lets you use one engine. Bevels along sides permit banked turns; standard cats usually turn flat.



The cathedral hull in its newest form resembles the old type doubled. Originally, it was a simple inverted V bottom. Split a conventional planing V hull down the centerline, transpose the two halves, and you have the basic form. Instead of smoothing wave impacts by deflecting water outward in energy-wasting waves, as the conventional V bottom does, the inverted V deflects it inward and downward to create lift. But, instead of banking inward on fast turns, like a V, the early cathedral jobs banked outward and sometimes flipped over. So today's designers place two inverted Vs side by side to form beamy new dual cathedrals that look like three separate hulls. These corner flat or can be designed to bank inward with beveled non-trip chines. A few modern cathedrals retain the single inverted V, but with a widened beam to provide stability.

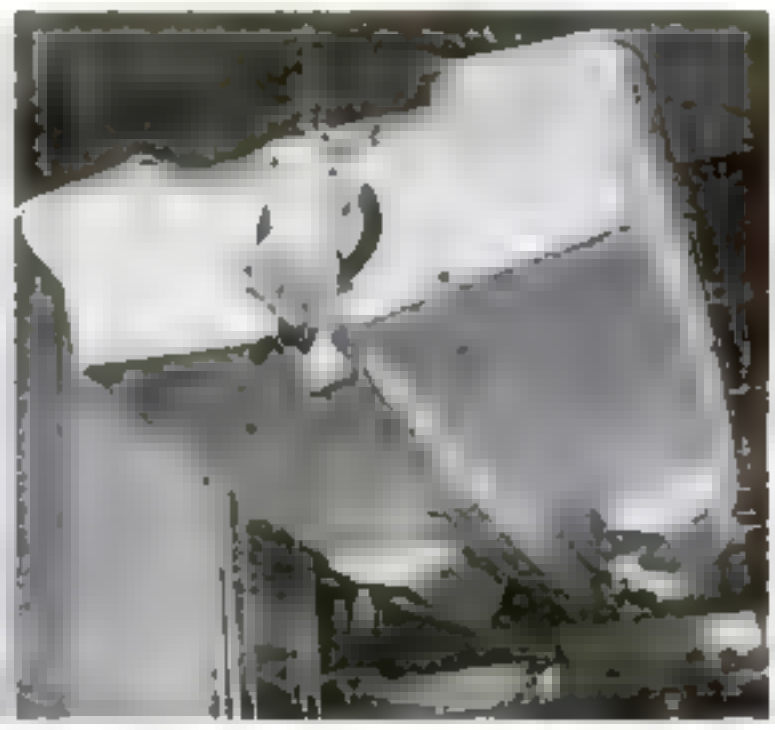
As cats and cathedrals are really several parallel hulls in one, their multiple bows enter a wave at different points. Each checks any yawing effect on the

[Continued on page 180]

Don't be fooled by look-alikes. These triple-entry hulls are all different

True trimaran has three separate V hulls to give it wide-beam stability without high drag. The middle hull in this Power Cat model cushions wave smacks, permits use of a single centered engine by eliminating turbulence

Dual cathedral looks something like trimaran, but is really two inverted-V hulls side by side. Straight outer sides and sloping inner ones push water in and downward, using the force to provide lift. This Cheyenne model smoothes out to an almost flat planing area at the stern, as above



Unusual triple hull is neither trimaran nor cathedral. Actually a three-pointer, this Outboard Marine design planes on forward steps and stern. Middle bow is out of water at high speed, adds lift at low speeds. Spoiler ridges flanking it prevent turbulence at prop.

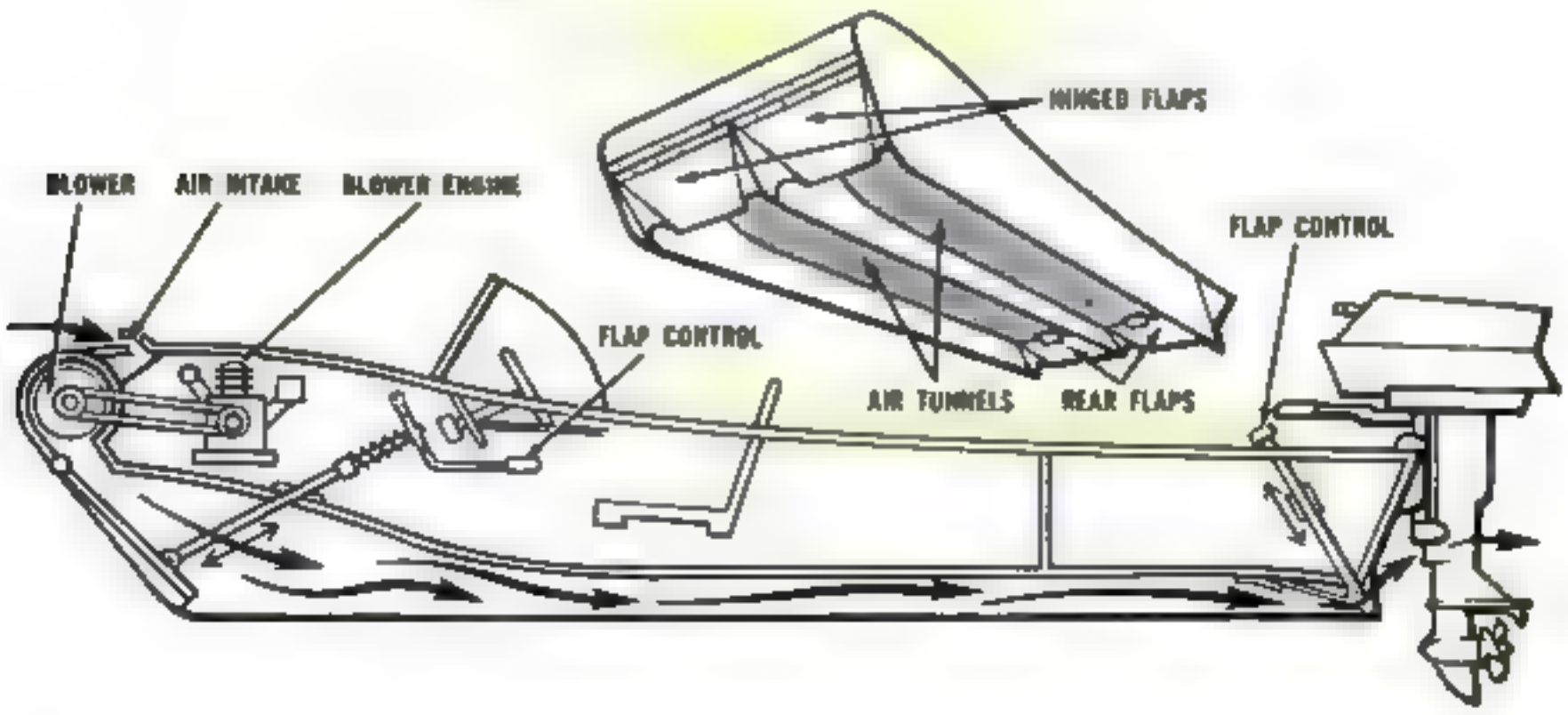
The Boat That Rides on a Bubble

LIKE the experimental GEM cars successfully tested in recent years, the unusual boat above rides on an air cushion created by a powerful blower

Robert W. Priest says that his interest in ground-effect machines led directly to development of the watercraft. An air blower is located in the bow. Parallel keels channel the air back to the stern.

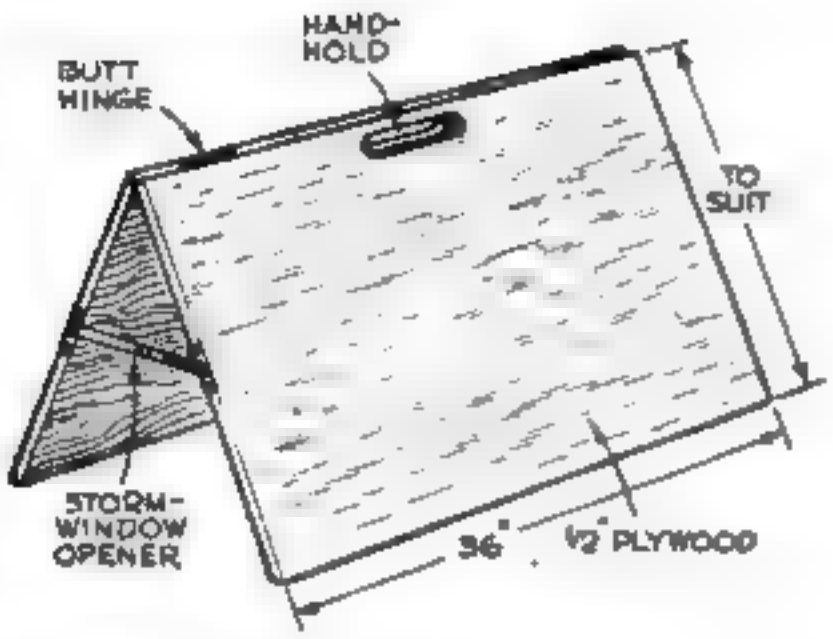
To demonstrate the principle, he built the boat above, shown on the Potomac River, to U. S. Navy landing-craft specifications. A World War II landing craft lumbered along at about eight m.p.h. The new one, buoyed by the air bubble, does 45. The Navy has accepted the design.

Now Priest's company, the Anti-Friction Hull Corp., Laurel, Md., is applying the principle to pleasure boats. A 37′ express cruiser hits 55 m.p.h. on two Chrysler V-8s. A power take-off from one engine runs the blower. At about $25,000 the price matches comparable conventional cruisers. Small models are coming, too, even down to outboard size. And performance will be hot —a 24′ test runabout, riding the bubble produced by a 17-hp. blower, tops 45 m.p.h. on twin 80-hp. outboards.



Patent sketches show how hinged flaps hold in air at the bow, force it back under the hull.

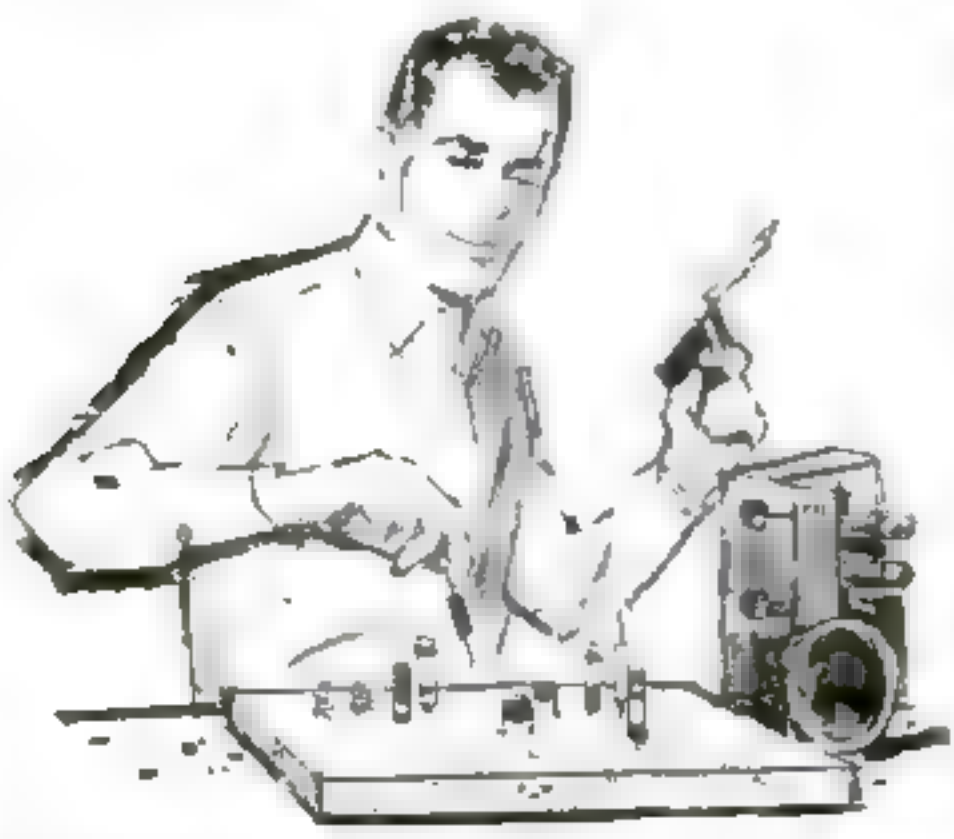
Short Cuts and Tips FROM PS READERS

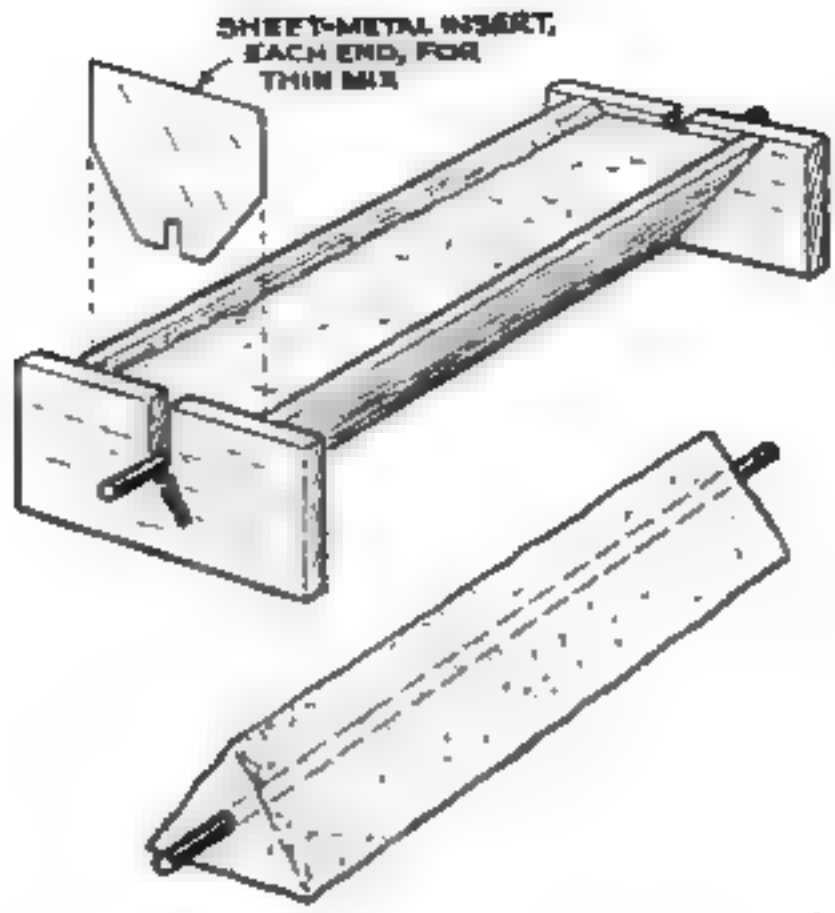


Plywood sawhorses fold flat

Many home owners don't own regular carpenter's sawhorses because they're too bulky to store and too heavy to lug around. Yet there are many household chores where a pair would come in handy. This folding model is the solution. It's sturdy, economical, simple to build—and stores flat. If you make a pair, you can grip one in each hand and carry them to the job site. —*A. W. Weber, Edmonton, Alberta.*

▶▶▶We hang our card table inside a closet door. We attached two steel corner brackets to the door, bent their protruding arms slightly upward, and taped them so they wouldn't scar the finish. The flat hooks slip between the table top and folded leg.—*Pearl Fitzpatrick, Gary, Ind.*





Casting reinforced-concrete posts

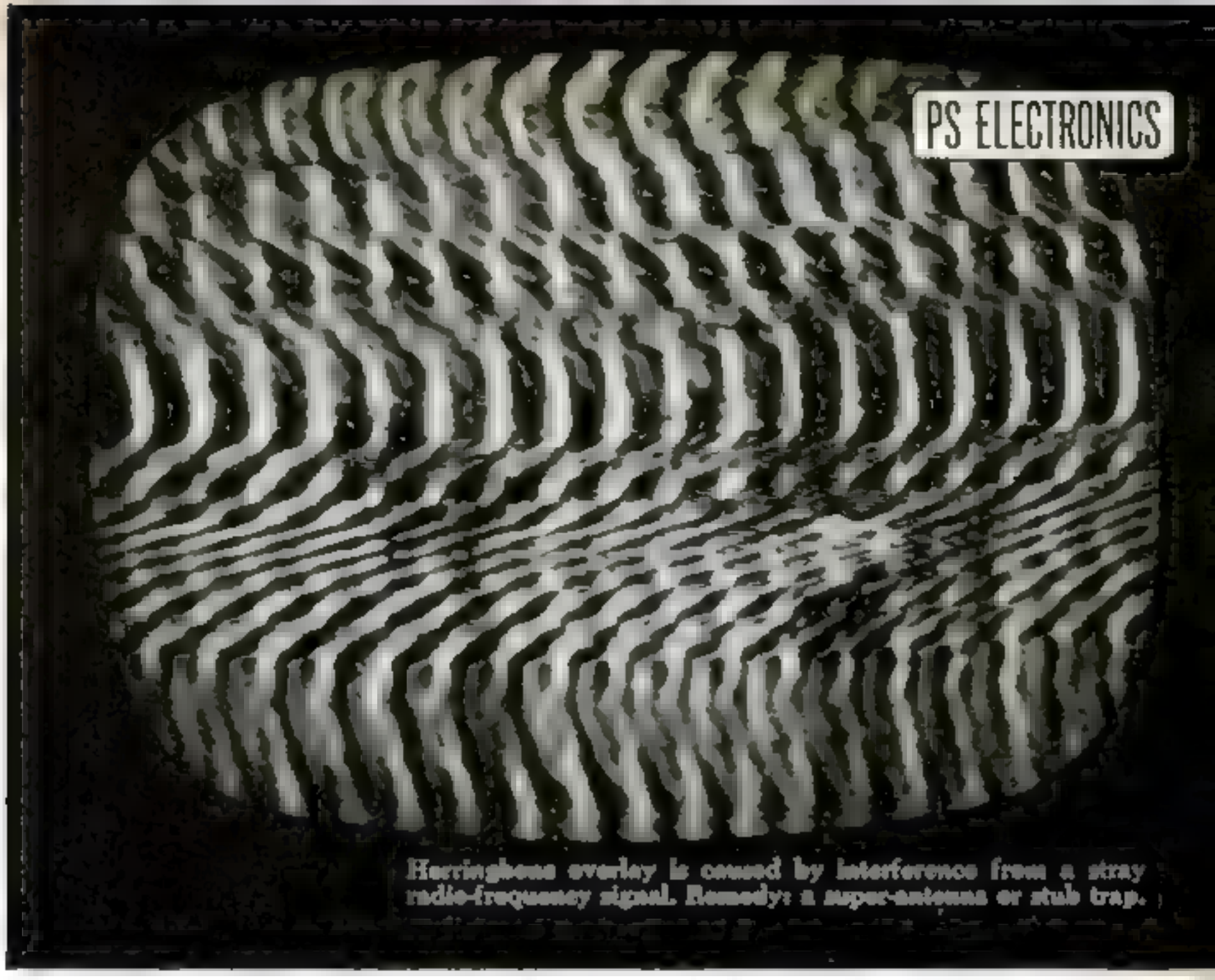
The simplest and cheapest mold for concrete posts is a V-shaped trough. You just nail two side planks between end supports as shown. You can embed reinforcing rods merely by notching the end supports to suspend the rods in position while the concrete is poured. Once the mix has cured, you remove it from its mold by flipping the trough upside down on the ground.—*G. E. Hendrickson, Argyle, Wis.*

▶▶▶I got tired of chasing through the house spraying every nook and corner with a bug bomb. Now I turn a big fan on full blast, aim it at a door leading to other rooms, and spray into the air stream for a count of five. In 10 minutes the house is bug-free.—*Dan Lamoreaux, Lawton, Mich.*

Plastic foam anchors small parts

Keep an inch-thick piece of rigid plastic foam at your elbow when you're assembling a radio. Plant the parts in it; they'll be within easy reach (as shown) and won't get lost.—*James R. Wozny, Cleveland.*

▶▶▶You can keep a good edge on mower blades by using an ordinary kitchen knife sharpener of the multiple-disk type. One with an angled handle is best. Before each use, tip the mower on its side (disconnecting the spark-plug wire for safety) and draw the sharpener over each side of the blade three or four times.—*Robert L. Hartman, Johnstown, Pa.*



Herringbone overlay is caused by interference from a stray radio-frequency signal. Remedy: a super-antenna or stub trap.

How to Track Down TV Interference

You can do something about those disturbances that mar your watching pleasure

By Art Margolis

THE other night I watched about three hours of programs at a neighbor's. I made note of the television interference (TVI) that was appearing. I counted car ignition, a couple of herringbone patterns, pulsating ghosts, a plane flying over, and rolling negative picture, smeary picture, windshield wiper and random pulses—all in time with an electric adding machine going in another room.

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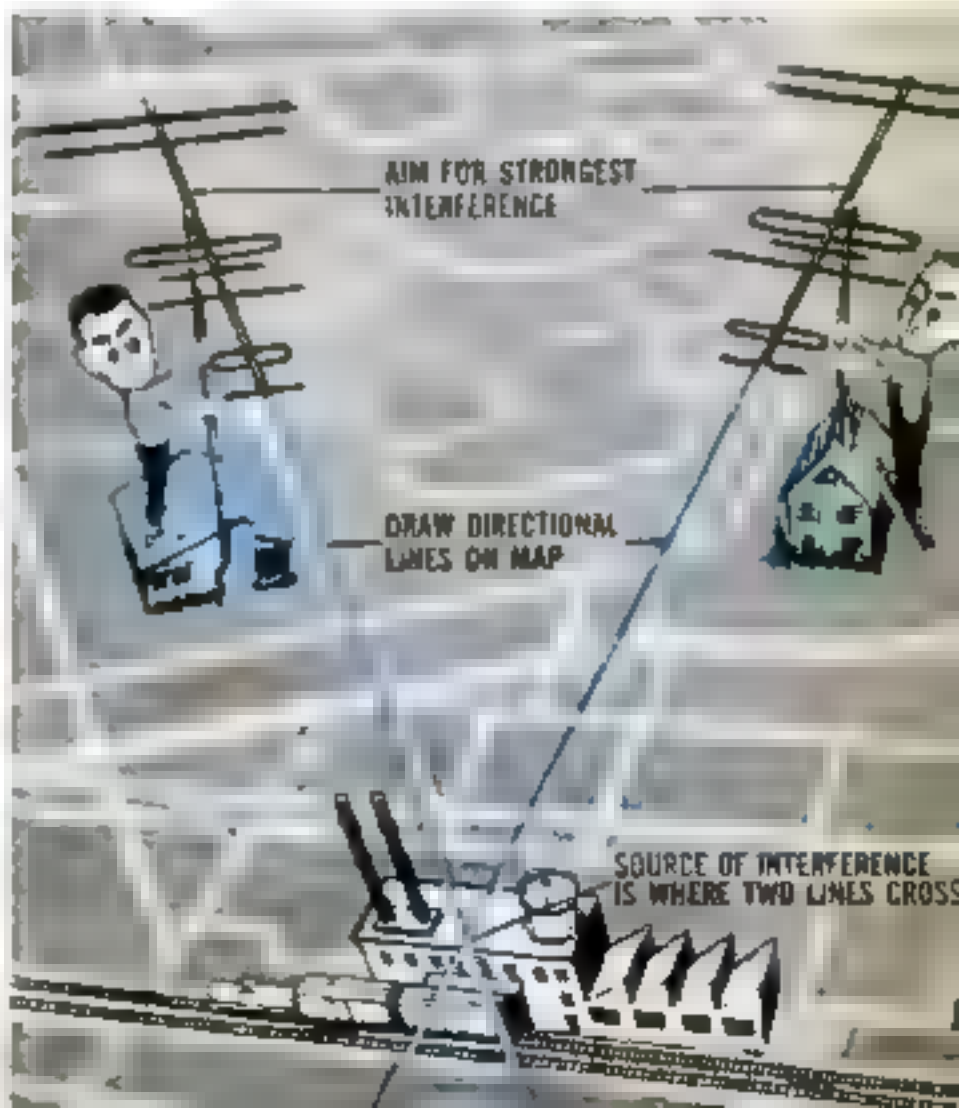
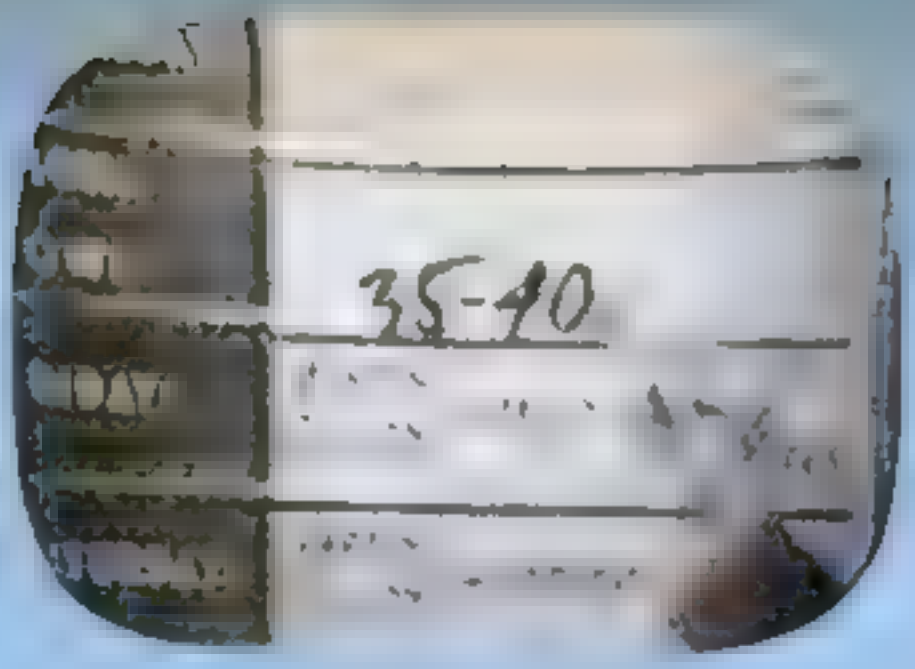


Here's what the different kinds of TVI look like

INTERFERENCE paints a picture on your TV screen that is as identifiable as a fingerprint. The most mysterious-looking are: 1) Co-channel TVI, with effects ranging from faint horizontal bars to a strange, snowy picture that pushes the local channel off the screen. 2) Adjacent-channel TVI, with effects ranging from a fine herringbone pattern to a motion that reminds you of a windshield wiper in action.



Ignition noise

Home-appliance interference

Airplane flutter, smear, and ghosts

Co-channel interference

Extreme co-channel interference

Adjacent-channel interference

Windshield-wiper effect

In addition to these common TVIs, you can probably think up some semipermanent forms you've lived through for days or weeks. Or you may be stuck right now with a permanent TVI that apparently doesn't vary. What can you do?

Plenty. What you need are a few professional secrets. All TVI can be remedied —more or less.

Close observation of the symptoms on your screen is the first step. You must type the trouble. Is it noise or RF (radio frequency)? Is its source a passing car or plane, or a power line? The next step is the remedy: antenna work, installing a capacitor, attaching a trap—or personal diplomacy.

Vehicle noise. Frequently, TVI originates in spark plugs. The hash produced by a car's ignition travels through the air, intercepts the antenna, and finds its way into the TV picture. TV waves bounce off planes overhead and enter your set at the wrong time, creating pulsating ghosts, shadows, and negative, smeary, or snowy pictures.

A few tricks with the antenna can reduce the black-and-white spark-plug tearing that covers your screen. The outdoor antenna and lead-in must be isolated at the source of the TVI. How? Install the antenna on the side of the house away from the street and run the lead-in down the same side, farthest from traffic. Use shielded wire and twist it a couple of turns a foot.

The reflected waves causing airplane-flutter TVI come down vertically. Remedy: Increase the horizontal pickup of the antenna—thus, in effect, reducing the vertical pickup. Stacking antennas, either double or quadruple, increases horizontal pickup and reduces airplane flutter.

Noise around the home. Any spark causes random noise bursts to fly invisibly through the air. But, according to its power supply, the noise will fill your screen or just appear as one or two horizontal lines. If it fills the screen, the power supply is DC as in a vehicle. If the TVI is a horizontal-bar effect, it is coming from a 60-cycle source: from your house, your neighbor's house, or the electric company.

If the spark maker is attached to a house power line, the noise radiates out of the line cord, which acts like a transmitting antenna. Also—the noise gets in the house wiring and rides atop the 60-cycle waves to enter all appliances on the same line.

Find right length for stub by shorting a piece of twin lead with a knife until you find the length that reduces TVI. Chart below shows frequency trapped by different stub lengths.

FREQUENCY (MC)	SHORTED STUB	FREQUENCY (MC)	SHORTED STUB
50	98"	130	37¾"
55	89⅛"	140	35"
60	81½"	150	32¼"
65	75⅛"	160	30⅛"
70	70"	170	28⅛"
75	65⅜"	180	27⅛"
80	61¼"	190	25½"
85	57⅝"	200	24⅛"
90	54½"	210	23⅛"
95	51⅝"	220	22⅛"
100	49"	230	21¼"
110	44½"	240	20½"
120	40⅞"	250	17⅝"

Thus both radiated and line-carried interference enter your TV—if radiated, through the antenna system; if line-carried, through the line cord. To clear up your picture, you must get rid of both types.

This is best done at the offending appliance, but first you must find it. Small arcs are produced in any electric appliance—from the doorbell at front, through all the gadgets and appliances in your house, back to the garage-door opener and yard tools at the rear.

The higher the voltage, the stronger the arc. Larger arcs are produced at the poles of the electric company. Consider this source of TVI, too, when you are on the search.

During a TVI seizure, walk around your house pulling plugs where possible and flicking switches where it's not, till the trouble clears. It's best to pull plugs, so you can check out plug and wall socket as well as the appliance. In a really tough case, flip off the juice at your circuit breaker. The arcing may be in there. If

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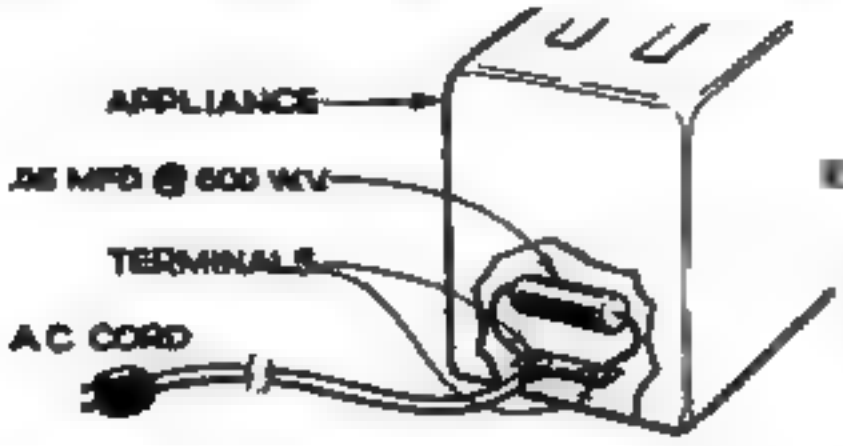
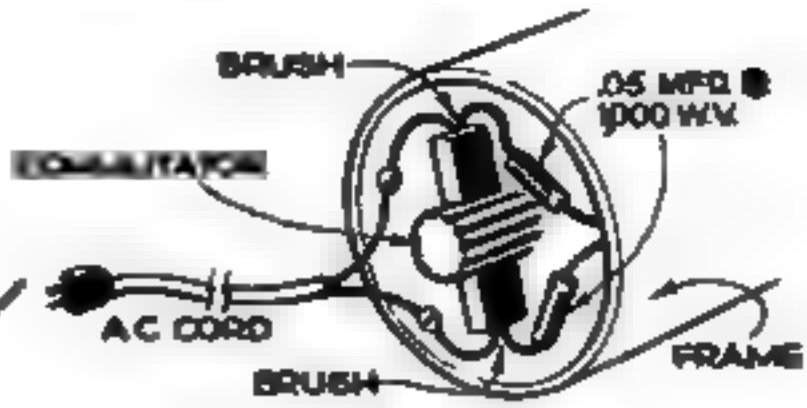
It's best to stop electric-power "noise" at its source





Interference from appliances is best handled by a capacitor across line-cord terminals. A capacitor from each brush to motor frame works best to reduce hash from small motors.

you have a fuse box, try the master switch.

If the trouble is not in your house, try using a portable radio as an electric bloodhound. A tube-type radio reveals interference better than a transistor type. Sparks are all-frequency and the radio will pop, squeal, and fry. Step outside and walk. If the noise increases, keep going. If it decreases, go the other way. As you approach the source, the noise level will increase.

Find the source and you can apply remedies. You'll save a lot of trouble by simply getting rid of old-style, clear light bulbs, or an ancient heating pad, toaster or iron. Otherwise, you can attach capacitive filtering.

A capacitor is the simplest noise filter, due to its ability to pass AC while blocking DC (in effect 60 cycle is DC in comparison to noise pulses). By attaching a .05-mfd., 600-volt capacitor as close to the arc as possible, the hash is reduced considerably. The best spot is across the line cord where the cord goes into the appliance.

Should the appliance have a universal motor, the carbon brush makes and breaks with the commutator bars thousands of times each second. Each touch produces a tiny arc. This noise is best filtered by attaching two .05-mfd., 1,000-volt ceramic capacitors. One end goes to the brushes and the other end to ground or the frame of the motor.

A lazy way to cope with home-generated TVI is with a 75-cent commercial line filter. Plugging it into your TV line-cord socket will filter some noise coming from the AC line. Installing it at the offending appliance is better. Some noise, however, will still radiate. The method is not as effective as connecting the capacitors inside the appliance.

Unwanted TV channels. While noise interference is never desirable, RF interference starts out as a wanted product. Only when it strays, unwanted, into your TV set does it become TVI. Two examples are co-channel and adjacent-channel interference.

Co-channel stations (two transmitters with the same channel number) are usually set far enough apart by the FCC so they won't interfere with each other. If you're an unfortunate between co-channels and receive both, your problem can be solved with money. Install a super-antenna with good directivity and a high front-to-back ratio. It should, in addition, be motorized for precise aiming at the desired station. This is the only cure.

Such localities, however, are few. Most people suffer co-channel interference only during atmospheric disturbances. Should horizontal bars appear or some strange snowy picture push the local channel off your screen, here's why.

The ionosphere—an electrical space band between 50 and 250 miles up—tends to reflect radio waves. TV waves, due to their high frequency, usually are not reflected and pass through the ionized layer into space. But sometimes the layer becomes extra-charged, and reflects TV waves. Then, a station too far away for direct reception may be reflected into your receiver.

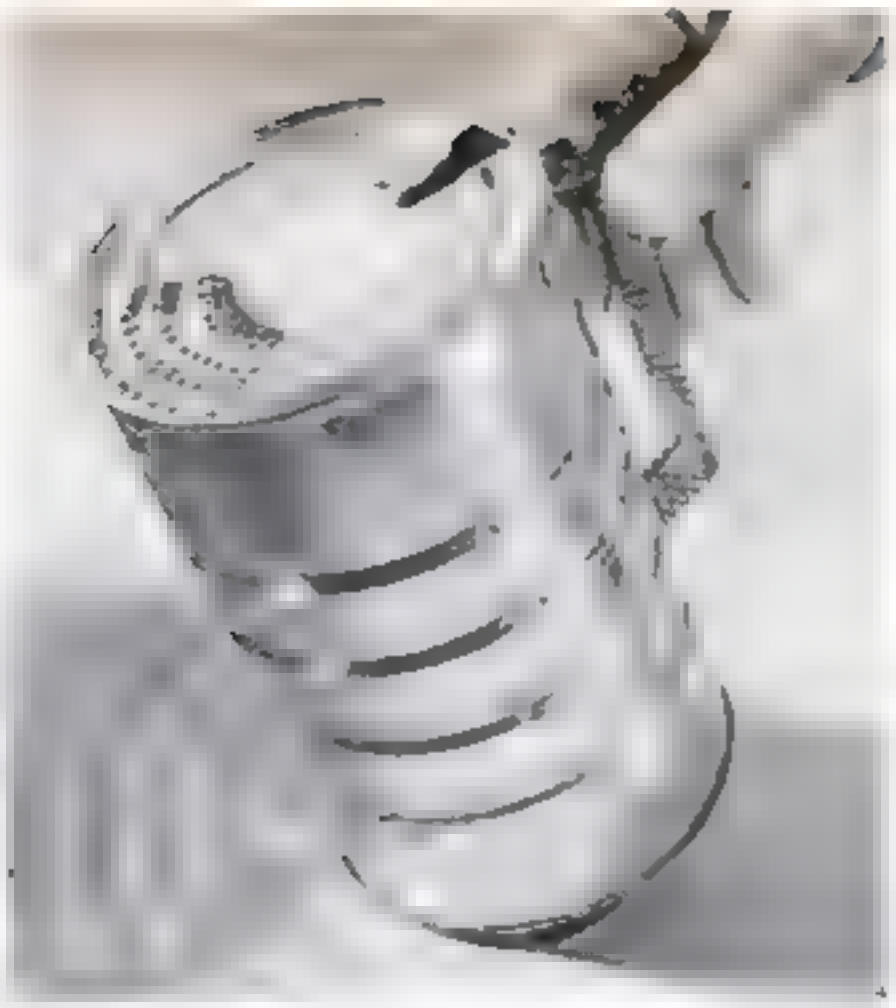
What to do? Just relax, try to enjoy the phenomenon, and wait it out. It shouldn't last more than a few days.

Adjacent-channel interference is another thing. This is the channel next to your local one, creeping in where it's not wanted.

For instance, there are areas where a channel 3 station is only 90 miles away from a channel 4. If you live between them

[*Continued on page 181*]

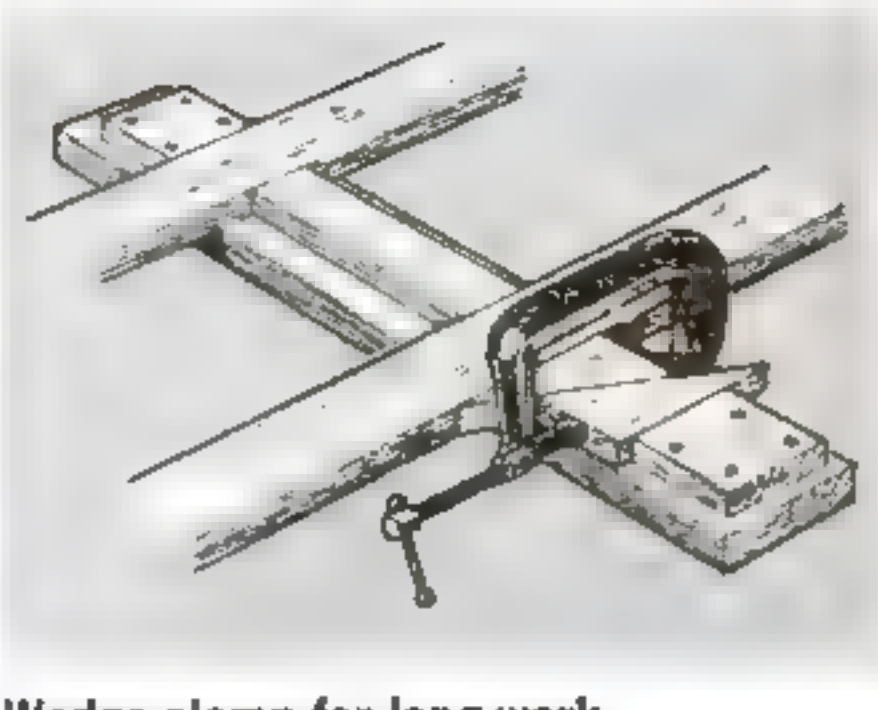
Short Cuts and Tips FROM PS READERS



No-cost outdoor watering can

Next time you open a large can of fruit juice, put only one puncture in the top. When the can's empty, punch a series of nailholes opposite this opening, and you've got a sprinkling can for small watering jobs. If you find the can hard to grasp, solder on a handle bent from a strip of tin.—*Ken Murray, Colon, Mich.*

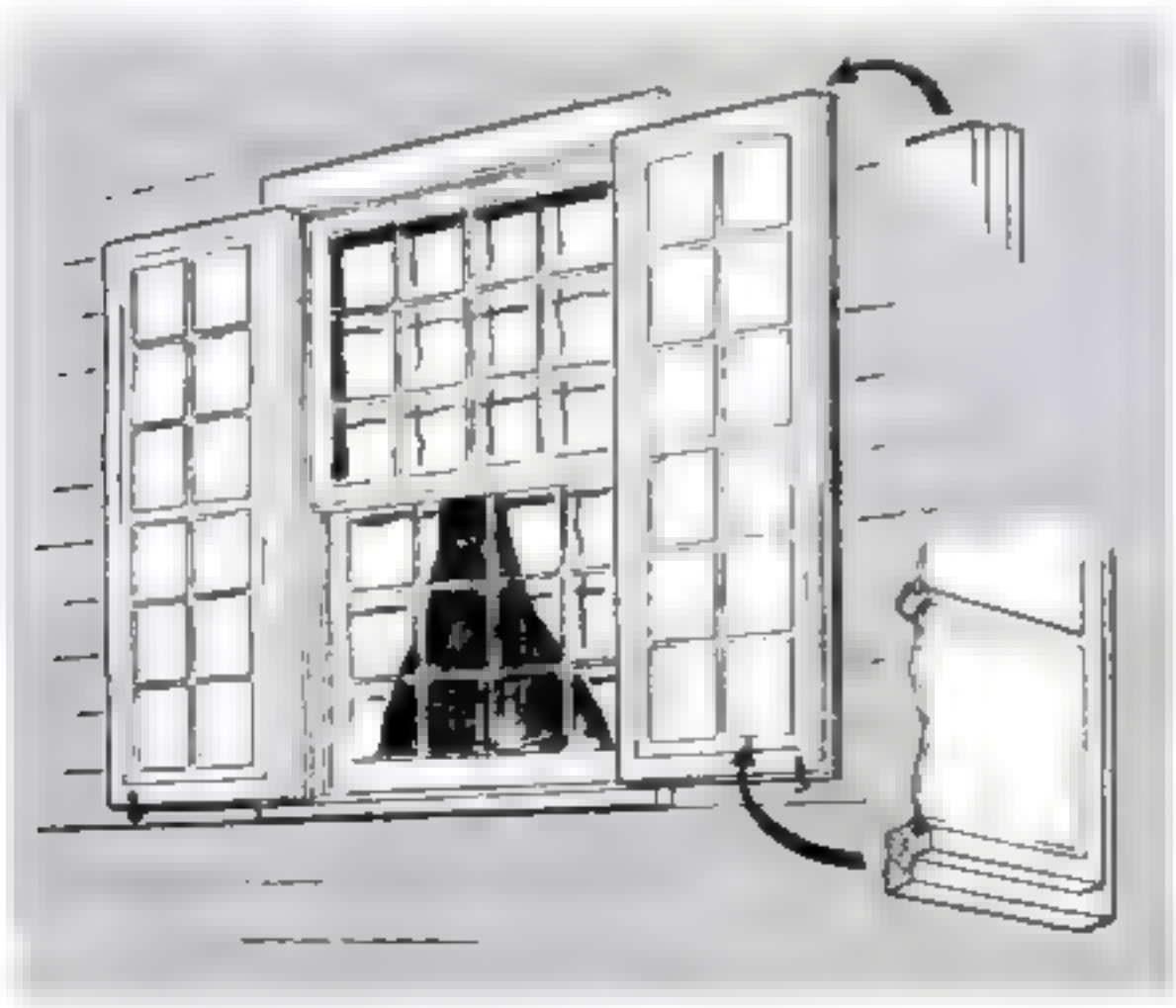
▶▶▶To avoid muddy golf-cart tracks, slip a plastic bowl cover over each dirty wheel after a round of golf. Then the cart can go into the shiniest station wagon or roll across the basement floor without wails from your wife.



Wedge clamp for long work

Need to glue up a flat assembly that's beyond the capacity of your clamps? If you don't own a bar clamp, you can make a substitute from scrap lumber and a C-clamp. Just nail two blocks to a blank, lay your assembly between, and apply pressure by tightening the clamp on opposing wedges.—*Charles Blackman, Harrisburg, Ill.*

▶▶▶A draftsman who collars his pencils with tape won't have to spin a pencil around to check the number every time he picks one up. A strip of red tape on a number 2 lead, green on a 2B, and so on, lets you choose by color.



Shutters double as self-storing storm sash

Shutters dress up narrow windows but, in most cases, serve no practical purpose. You can put them to work without sacrificing their decorative function if you substitute glass for louvers or solid panels. Design a pair with the same size lights as the window, and you'll have a permanently attached storm sash that you can swing shut during the winter. You might even make the glazed panels removable, so you can replace them with screen inserts for summer use.—*H. L. Williams, Hadlyme, Conn.*

Year-Round Play Court for Your

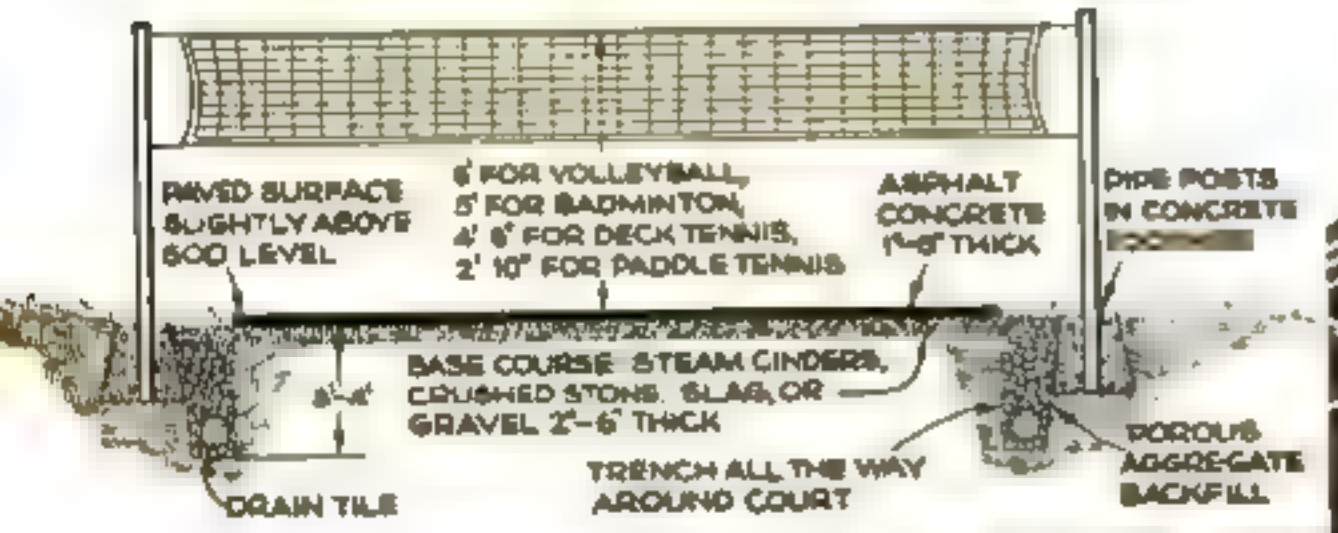
FOR a surprisingly modest investment, you can have an all-purpose play area in your back yard—a paved surface that's guaranteed to become the liveliest hundred square yards in town.

The layout shown—turn the page for a scale diagram—gives you regulation courts for badminton, deck (ring) tennis, and paddle tennis. Raise the net to 8' and you're ready for volley ball.

Take the net away and you've got a roller rink—one you can flood next winter so skaters can switch from wheels to blades. The superimposed court lines form a perfect shuffleboard lane. Add a backboard at one end and paint a foul circle for shooting baskets. Put a tall pole at the center of this circle, and turn the kids loose for tether ball. Remove the pole and use its socket to polish your putting skills.

CONTINUED

What's involved in paving a game court



Multiple use keeps court busy all year—sometimes with two activities at once. Drainage in cross section above is for problem soils or locations. A steam-cinder base course can be laid and compacted directly on the bottom of the excavation. Alternate materials should have 1" bed of sand or screenings beneath, worked into the soil.

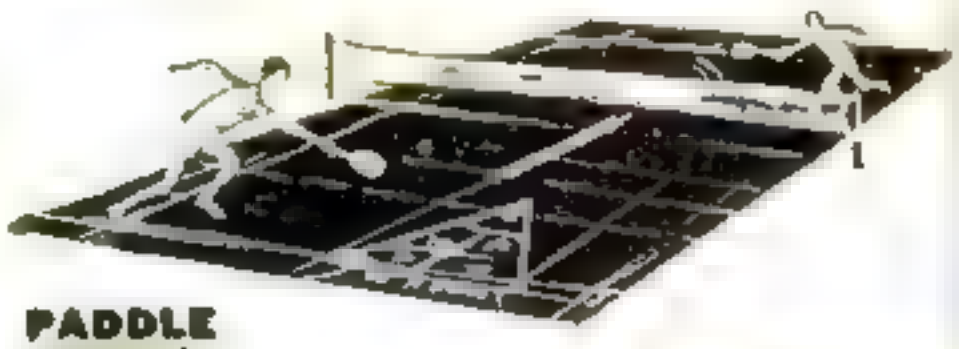
SHUFFLEBOARD

Back Yard

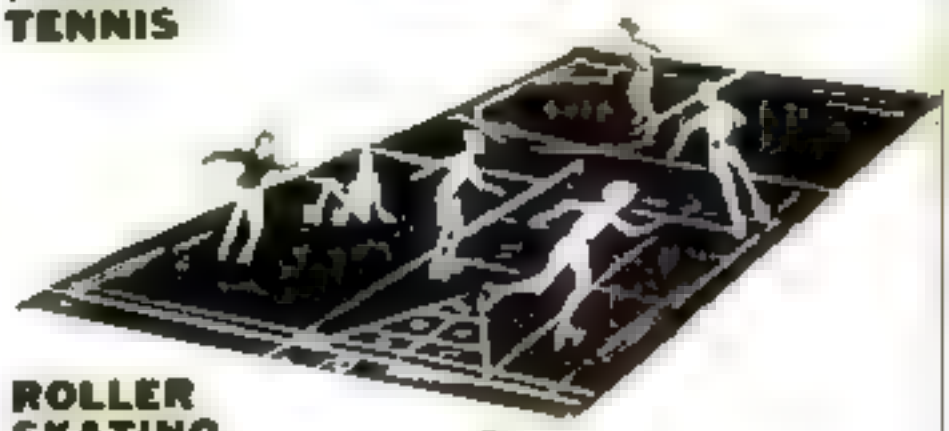
By Alfred W. Lees

BASKETBALL

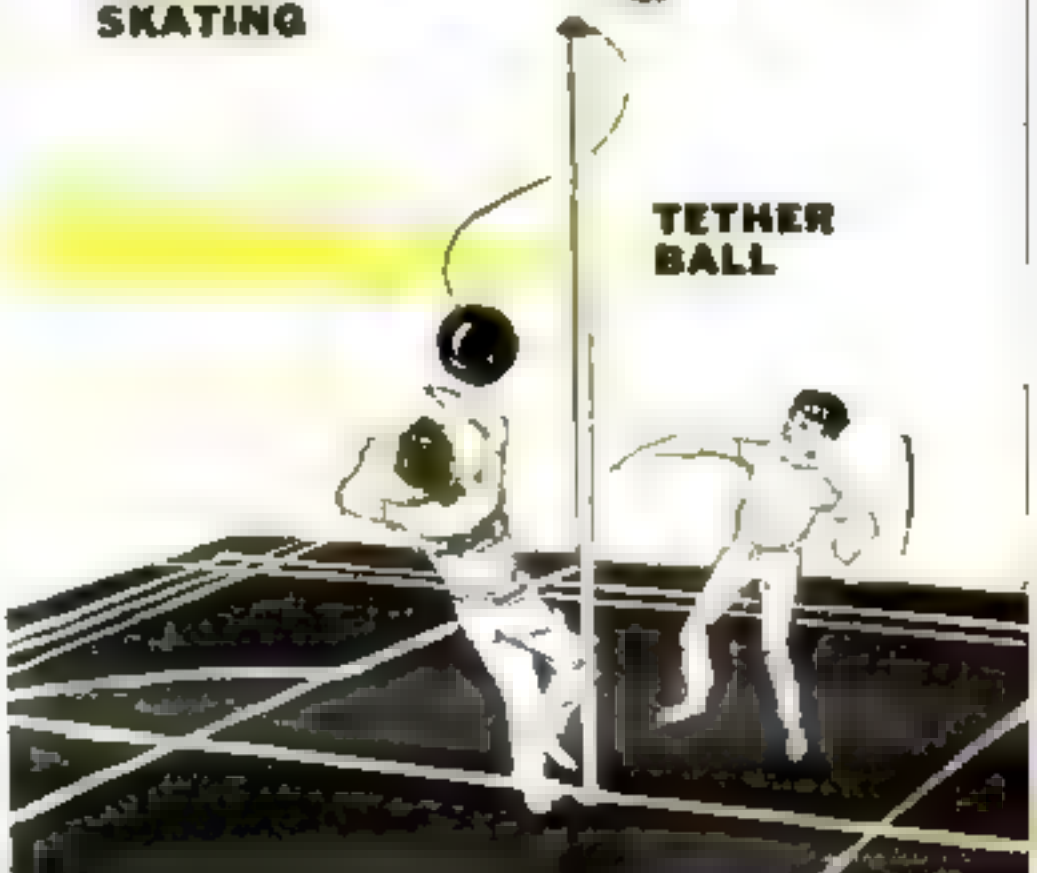
All this and badminton, too



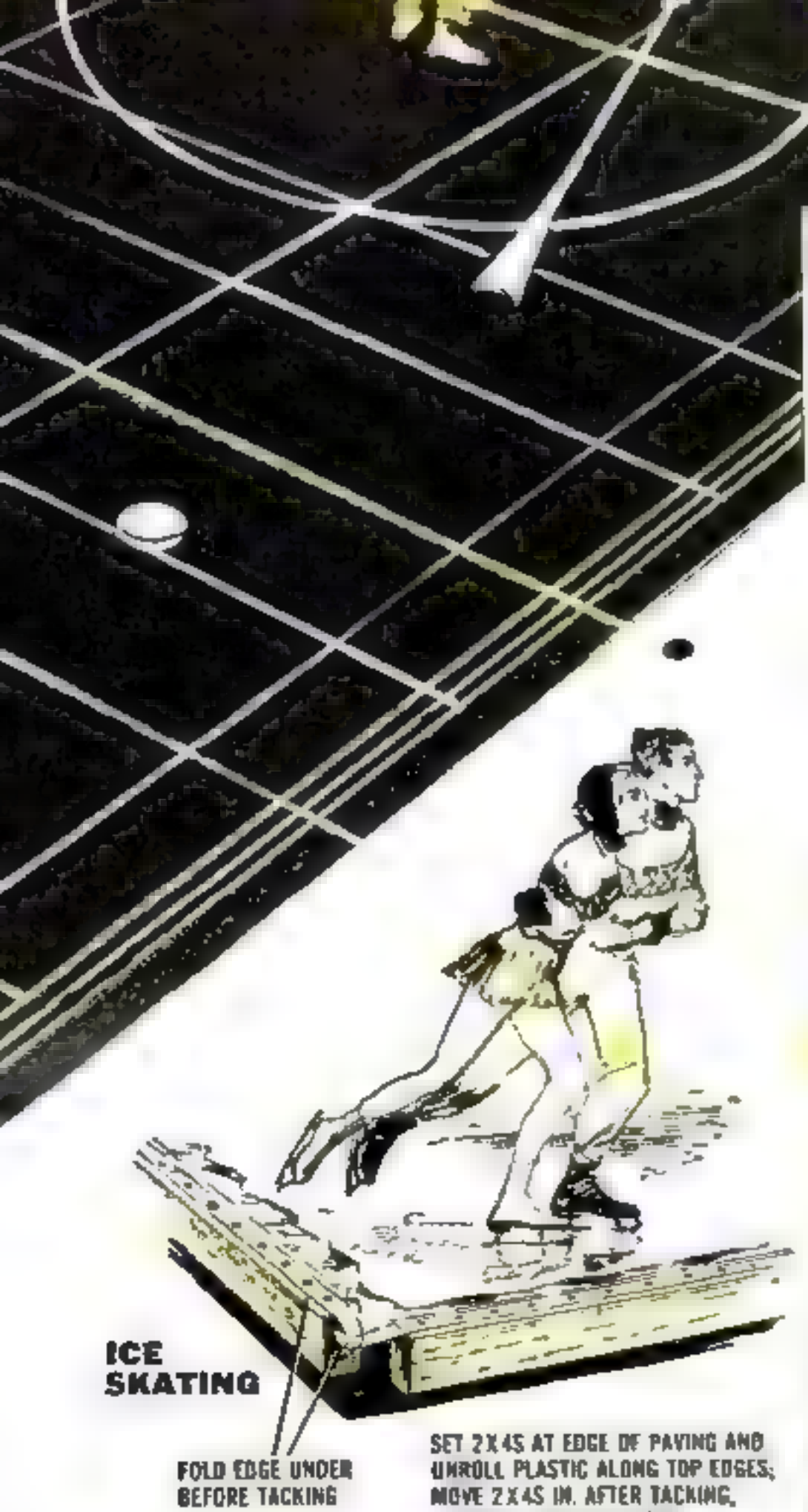
PADDLE TENNIS



ROLLER SKATING



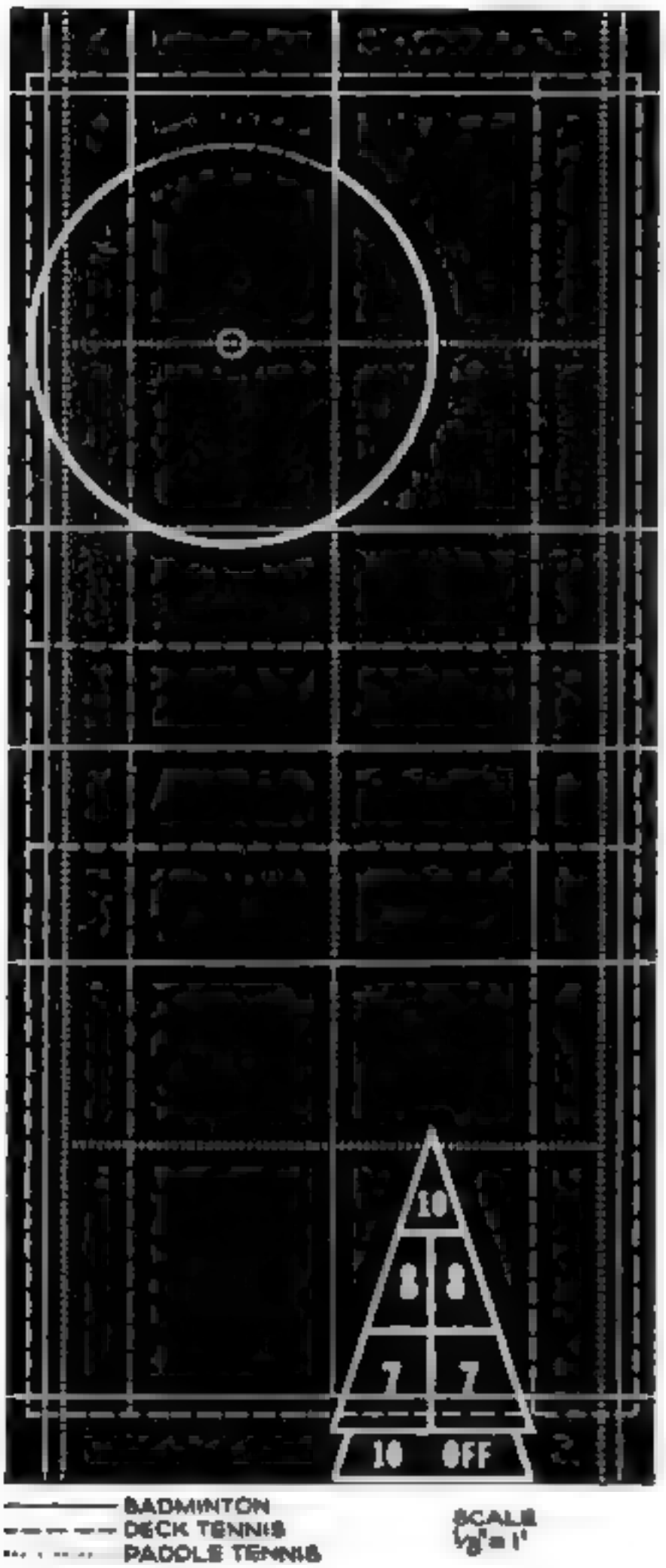
TETHER BALL



ICE SKATING

FOLD EDGE UNDER BEFORE TACKING

SET 2X4S AT EDGE OF PAVING AND UNROLL PLASTIC ALONG TOP EDGES; MOVE 2X4S IN, AFTER TACKING, TO FORM SHALLOW BASIN



The best all-purpose paving for a play area is asphalt—the same blacktop that's so popular for driveways. In fact, if you have a long, straight driveway you've been meaning to pave, you might combine the jobs, making a 44' section of it double width for double use.

An area to be used for net games and skating must have a smooth, level surface. This calls for proper excavating and grading, and compacting by heavy equipment. Estimates from a paving contractor are usually free, and may start as low as $2 to $2.50 a square yard. That would mean $200-up for the badminton court shown.

Cold and hot mixes. The "up" varies according to the local price tag on the type and quality of the asphalt application you choose. For best results, it should be a plant mix. There are two types: One is termed "cold mix" because the aggregate is mixed with either liquid or emulsified asphalt, with no heat involved in either preparation or installation. It is usually laid 2" to 2½" thick over a 3" to 8" base. The other type—hot mix—is usually called asphalt concrete. It's mixed hot at a local plant, trucked to the site, and laid hot (225-325 degrees), to a thickness of 1" to 3" over a 2" to 6" base. It offers greatest durability and least maintenance of all asphalt paving, and has a dense, nonporous surface. You may pay a little more.

That $200 estimate, then, is for a minimum cold-mix installation, and assumes there's a contractor near you. Transporting heavy paving equipment any distance runs the price up fast. And be sure the location you have in mind is accessible to such equipment once it arrives.

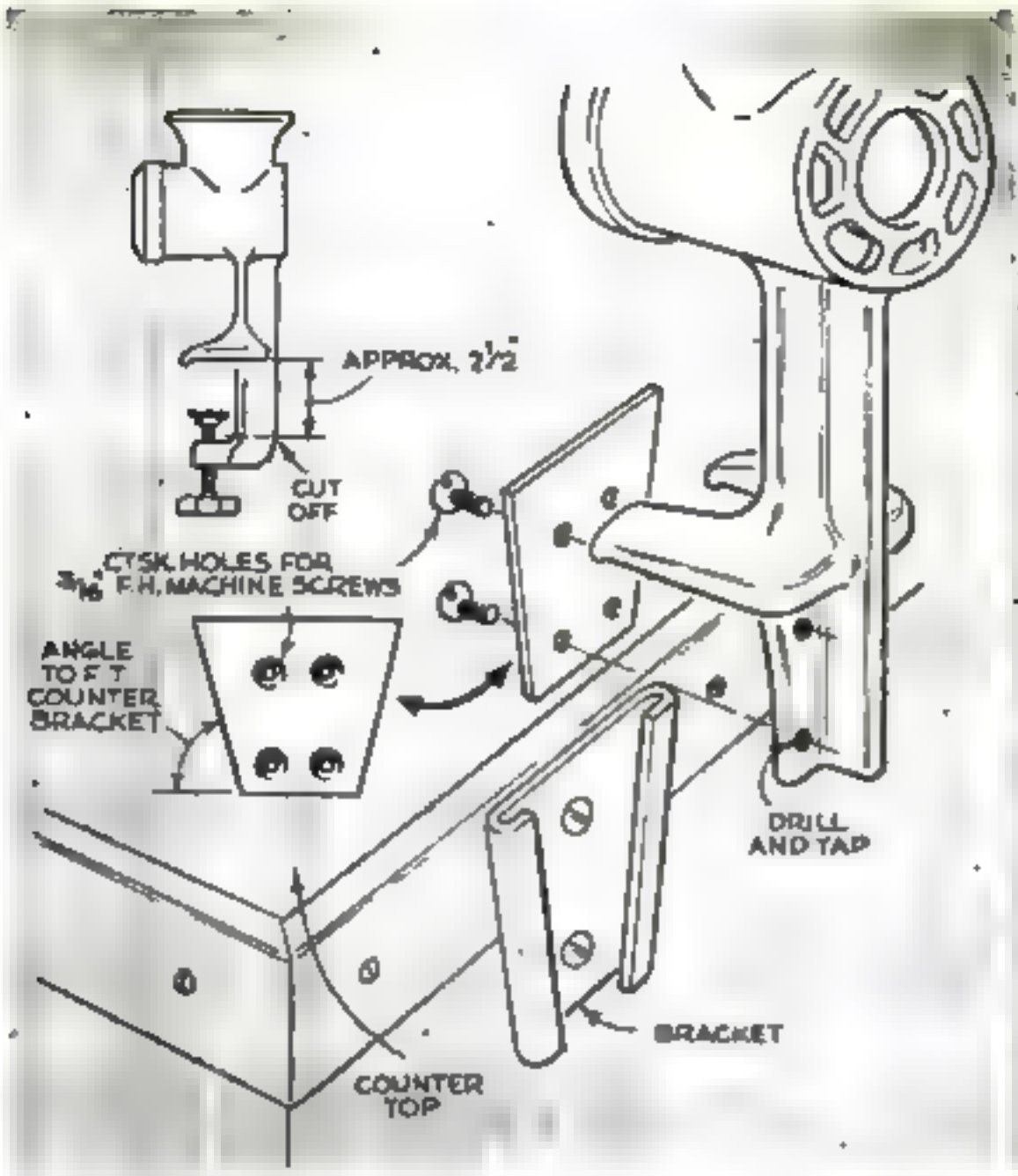
How thick a slab? In free-draining gravelly or sandy soil, a base course and surface of minimum thickness may do the job—and provisions for drainage might be less elaborate than we show in the cross section on the first page of this article. In fact, it may only be necessary to keep water from ponding on the asphalt, and this can be achieved merely by sloping the surface at least 1" per 30'. It can be a single-direction slant, so that one end of the area is 2" or 3" below the other. If this is impractical on your lot, the slope may drop in both directions from the net, with each end of the court an inch or two lower than the center.

Silt or clay soils require asphalt and base courses of greater thickness and may—in problem locations—call for a sloping trench around the edge of the court, as shown in our cross section.

The court lines can be laid out in contrasting colors of latex paint—perhaps yellow for badminton, blue for deck tennis. No markings are needed for volley ball since court sizes are not rigidly standardized (except in official competition). The court shown (above, left) is smaller than the usual volley-ball layout, so the paving edges can determine your playing area.

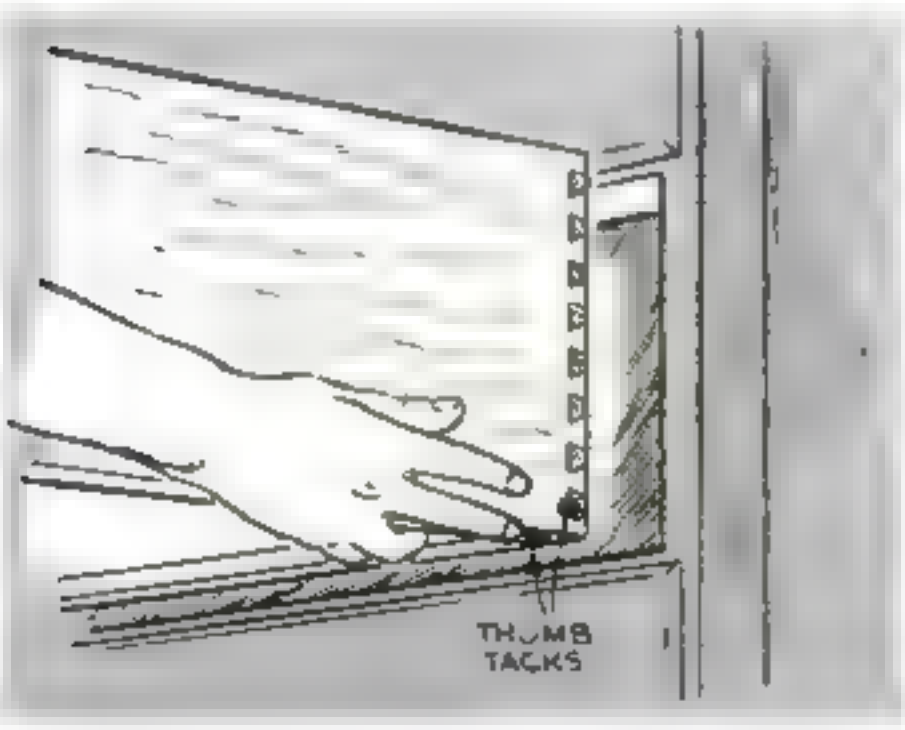
The net posts should be located beyond

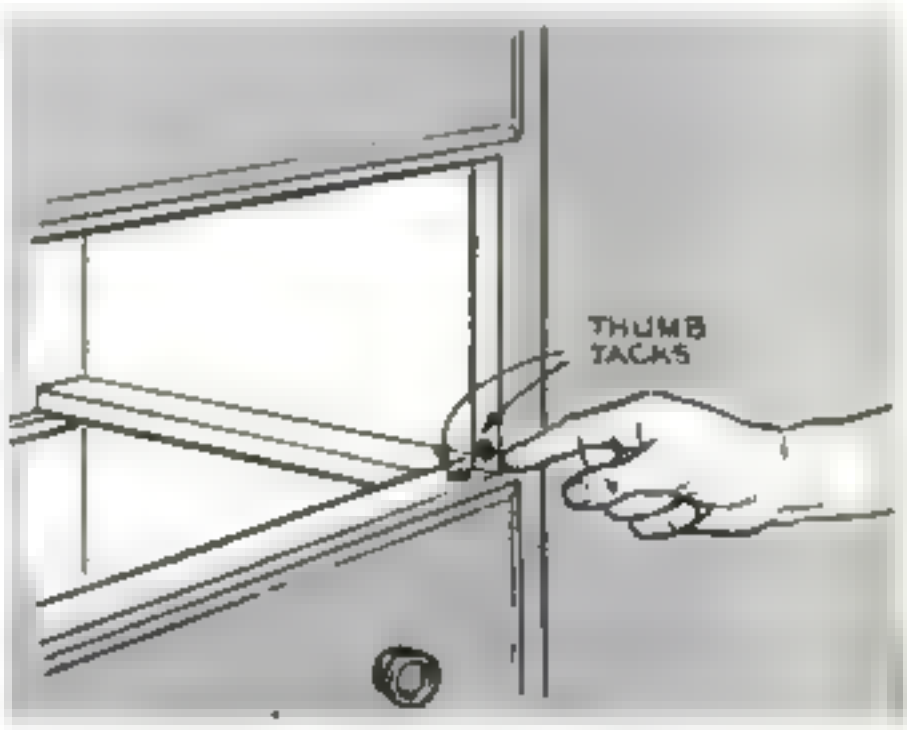
[*Continued on page 184*]



Bracket for flush-mounted appliances

Modern kitchen counter tops are often flush with the sides, with no overhang on which to attach clamped appliances such as meat grinders. You can adapt these units for flush mounting by trimming off the clamping screw and attaching a plate that will slip snugly into the type of bracket used for wall-mounted can openers. If you can't buy the bracket, make one of cold-rolled sheet at least 1/16" thick. The mounting plates—one for each appliance to be converted—are cut from the same stuff. Attach the plates directly beneath the claw feet that rest on the counter top; mount the bracket where it'll be unobtrusive.—*H. A. Fluchere, Irvington-on-Hudson, N. Y.*





Tacks make drawers slide easier

Old drawers come alive, and new ones seem self-propelled when a few thumb tacks are strategically placed to minimize friction. As shown, eight are required for each drawer: four at the rear corners, and four at the front of the drawer opening. Rub a little paraffin on the runners, too. —*Jack Kenison, Tacoma, Wash.*

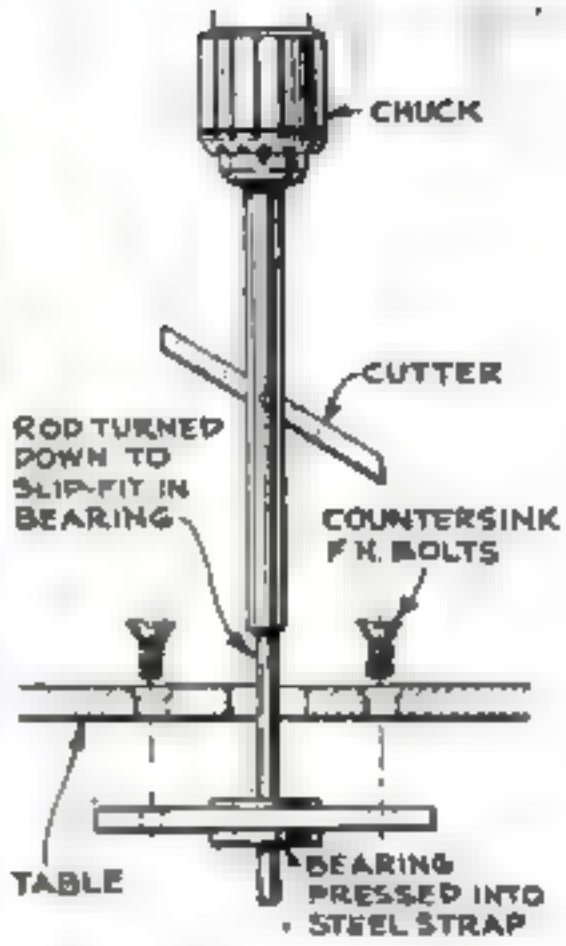
Short Cuts and Tips FROM PS READERS

Drill-press boring bar for wide, deep holes

Fly cutters set up great centrifugal force that's hard on the chuck and lower bearings of a drill press. That same force limits their depth of cut to about 1¼", since a longer shaft between cutter and chuck tends to whip.

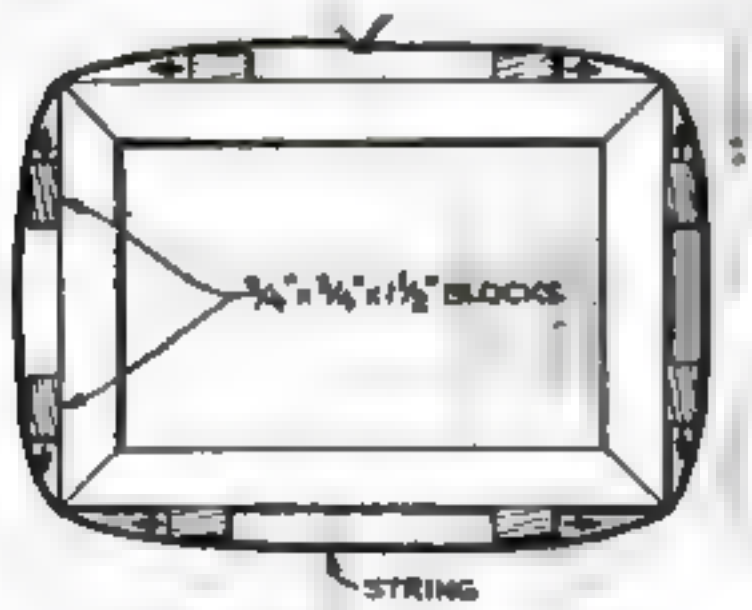
By anchoring the shaft in a *bottom* bearing, as well, I've made a boring rig with no practical limits as to cut.

Depth is limited only by the capacity of your drill press. It's the only method I know of for cutting wide, deep holes. As the cutter is lowered, the rod passes through the table and the bearing.—*Ray E. Starnes, Mitchell, S.D.*



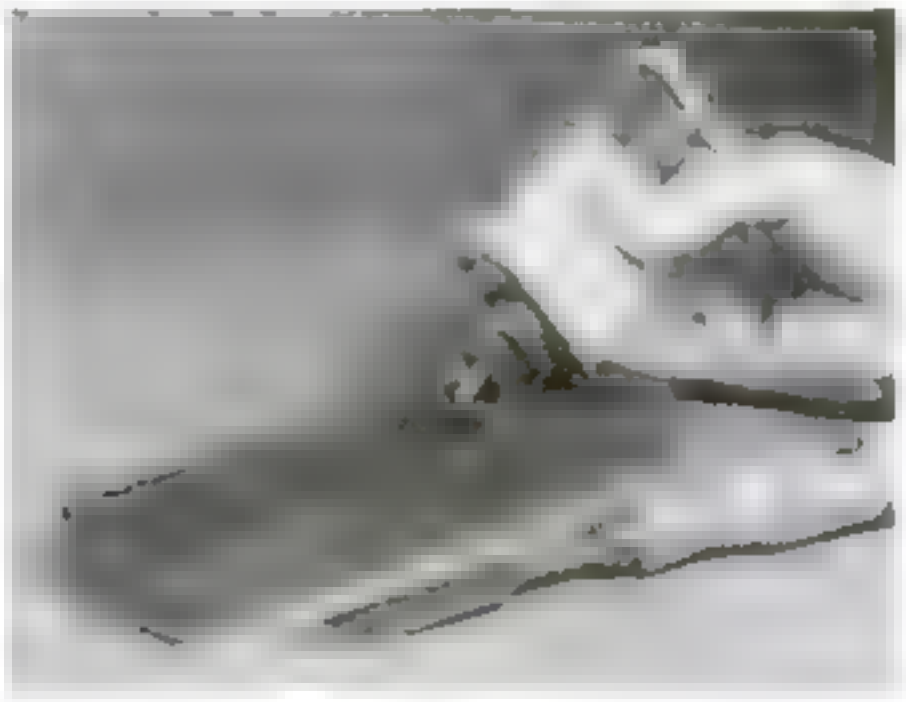
▶▶▶Stripping the finish from furniture knobs can be a problem. Liquid remover tends to drip off before it softens the paint or varnish. I put small knobs in a covered jar with a bit of remover and keep them wet by shaking until the remover does its work. Then I clean them with a toothbrush —*A. W. Weber, Edmonton, Alberta.*

▶▶▶Butting strips of wallpaper gives a neater effect than overlapping—but just try it with vinyl paper! It stretches—and sometimes the pretrimmed edge isn't straight. I lap strips about ¼", place a straightedge on the lap, slit through both strips with a razor blade, and peel away the waste.—*Alan Spirer, Mamaroneck, N.Y.*



Picture-frame clamp from twine

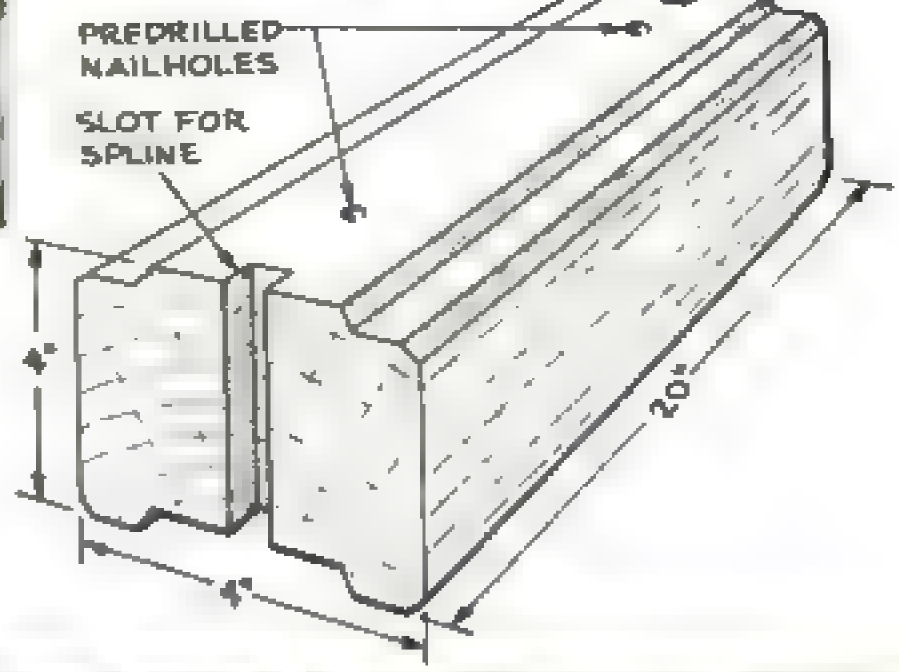
The glue clamp I use for mitered frames doesn't cost me a cent. I place the frame flat, loop several turns of twine loosely around it, and tie a knot. Then I lift each piece separately to apply glue. When the frame's reassembled, I slip blocks under the twine and draw it taut by sliding them to the corners.—*W. Dawson, Dayton, Ohio.*



Lighter-fluid can dispenses oil

Handier than an oilcan for storing and applying whetstone kerosene is a discarded lighter-fluid container. Its swivel shut-off spout lets you tote it in a pocket or toss it into a toolbox without fretting about leakage. The plastic spout pries off for filling, yet snaps back on as tight as new.—*Bob Gilmore, Sonoma, Calif.*

Build a Vacation Home of Wood Bricks



YOUR whole family can pitch in to help build an attractive vacation house like this one. Little construction knowhow is needed. The walls are built of solid wood bricks with tongued and grooved edges that go together as easily as children's blocks.

The wood bricks do triple duty as exterior finish, basic structure, and interior finish. Their 4" thickness provides adequate insulation in all except the extreme northern part of the U. S.

Construction begins with the pouring of a concrete slab. The plates (first course of the walls) are lengths of milled lumber with a drip cap on the outer face. Bolted to the foundation, these guide the placement of the bricks. Half lengths and special bricks for corners and partitions simplify assembly. Rafters are nailed to the top of the wall, sheathed with plywood, and covered with a standard gravel-surfaced roofing.

The novel building system originated in South America and was introduced in the U. S. by the Southwest Settling and Development Co., a division of East Texas Pulp and Paper Co., Jasper, Tex.

Ready-cut roof members, wood bricks, trim, battens and other lumber needed to build a 20'-by-29' home can be purchased for about $950, plus shipping charges. To save on shipping, you can also buy just the bricks and use local lumber for the other parts. Working plans for the vacation house are included with the bricks.

Solid interior wall of a wood brick house looks like this when finished. Bricks are milled from four-by-four lumber too short or otherwise unfit for conventional uses. End joints are locked by inserting splines in the matching grooves. Before laying, blocks are brushed with glue (lower left). As shown in same photo, a continuous plate serves as the bottom course. It is milled to fit the grooved underside of the wood bricks. Eight-penny nails are driven through predrilled holes (lower right

LIGHT UP —for safety's sake!

Here's how to keep guests from stumbling into the barberry bush or wading in the lily pond

By Stanley Schuler*

NOW that so many of us are spending so much time in outdoor living, adequate lighting of walks, paths, steps, driveways, parking areas, and pools has new importance. It is your best insurance against accidents. And it pays an extra dividend by adding to the appearance of your property.

You don't have to turn night into day or spend a fortune. The equivalent of brightest moonlight is often enough. However, you should vary the light intensity in relation to four conditions:

- The hazard. The greater this is, the more light you need. Steps must be lighted better than walks.
- The usage. The more a thoroughfare is used, the more light you need. A front walk requires more light than a driveway (unless you use the latter as a play area).
- The proximity of the thoroughfare to the house. Your eyes adjust slowly when you step from a brightly lighted house to a

High or low lights for front walks

Curved entrance walk (at left) is flooded with soft, glareless light from low mushroom fixtures spaced 6' to 8' apart at walk level. Conventional post light (below) illuminates front and side walks around house. Next page: lower lights pick out sharp turn

dimly lighted walk. So you probably need more light on the walk near the door than at a distance.

- The color of the paving. Dark paving absorbs light. Light-colored paving reflects it, and you need less wattage.

These facts are guideposts. To determine just how much light you need on walks and driveways, you'll have to experiment. But it's unlikely that you'll want anything larger than 150-watt floodlamps—the type with weather-resistant glass. Depending on fixtures and where you place them, you can often do an effective job with smaller bulbs.

What fixtures? It's best to place fixtures either high above the ground or fairly close to it, not at eye level

If you mount the lights high—10′ to 20′ so they don't shine directly in your eyes—you achieve a wide distribution of light with only a few lamps. The simplest fixtures for such an installation are PAR bulbs in weatherproof, adjustable lamp holders. The alternative—weatherproof, bullet-shaped reflectors with ordinary bulbs—are more expensive; but they do a better job of concealing the direct glare of the bulbs and can be focused more precisely.

If you install lights from ground level up to about 7′, you need more of them. You also draw attention to ugly paving and attract bugs. On the other hand, you concentrate the light where it is needed most and you lessen glare from the bulbs. For near-ground installations, you have a wide choice of attractive fixtures.

How to light walks and paths. Use any of the following.

1. High-mounted floodlights. Aim them

CONTINUED

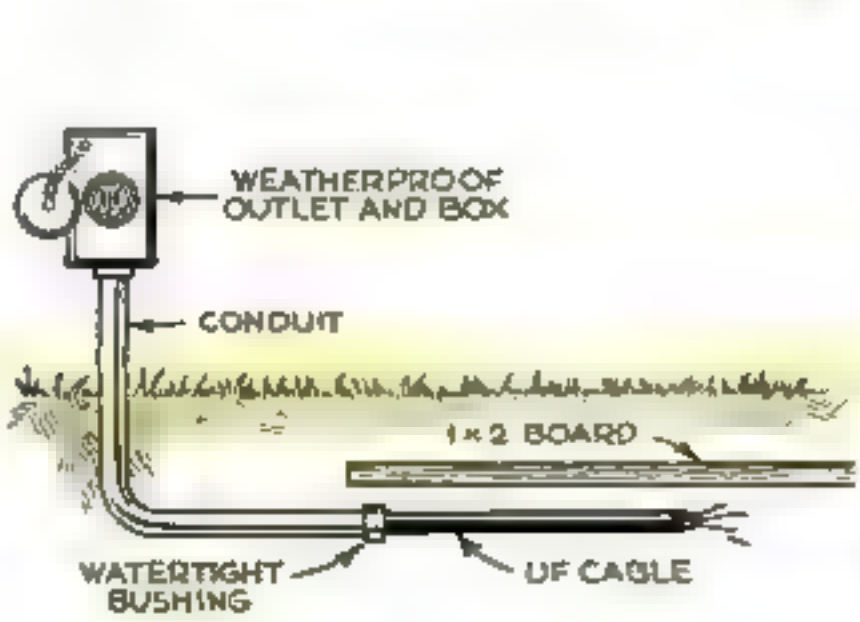
*Author of *Outdoor Lighting for Your Home and Grounds*, published this month by D. Van Nostrand, Princeton, N. J.

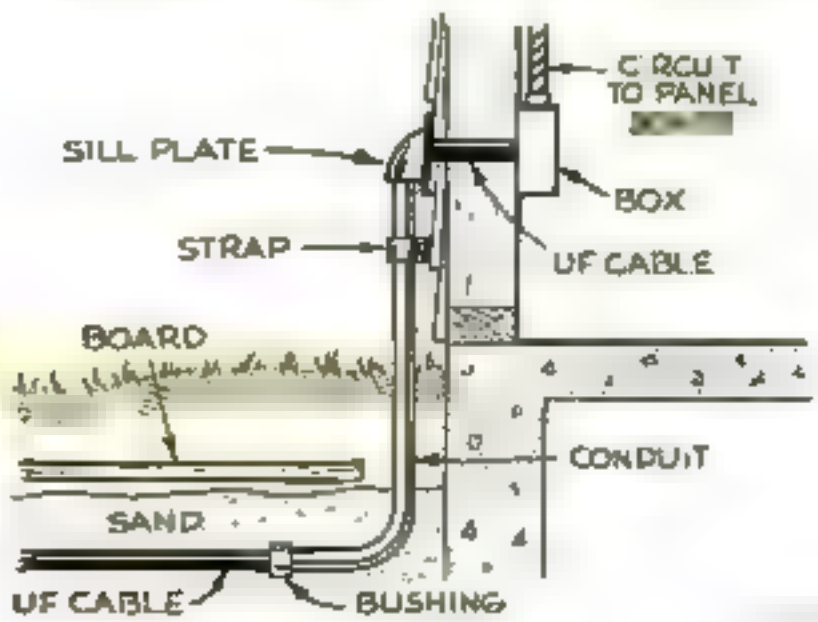
Automatic fixture has a built-in photoelectric switch that turns yard light on when night falls, off at dawn. The unit is made by Bryant Electric Co., Bridgeport, Conn., for $16.

Chinese-lantern fixtures, flanking garden steps —one at top, one at bottom—show up treads and risers to protect against dangerous tumbles when entering or leaving lighted patio.

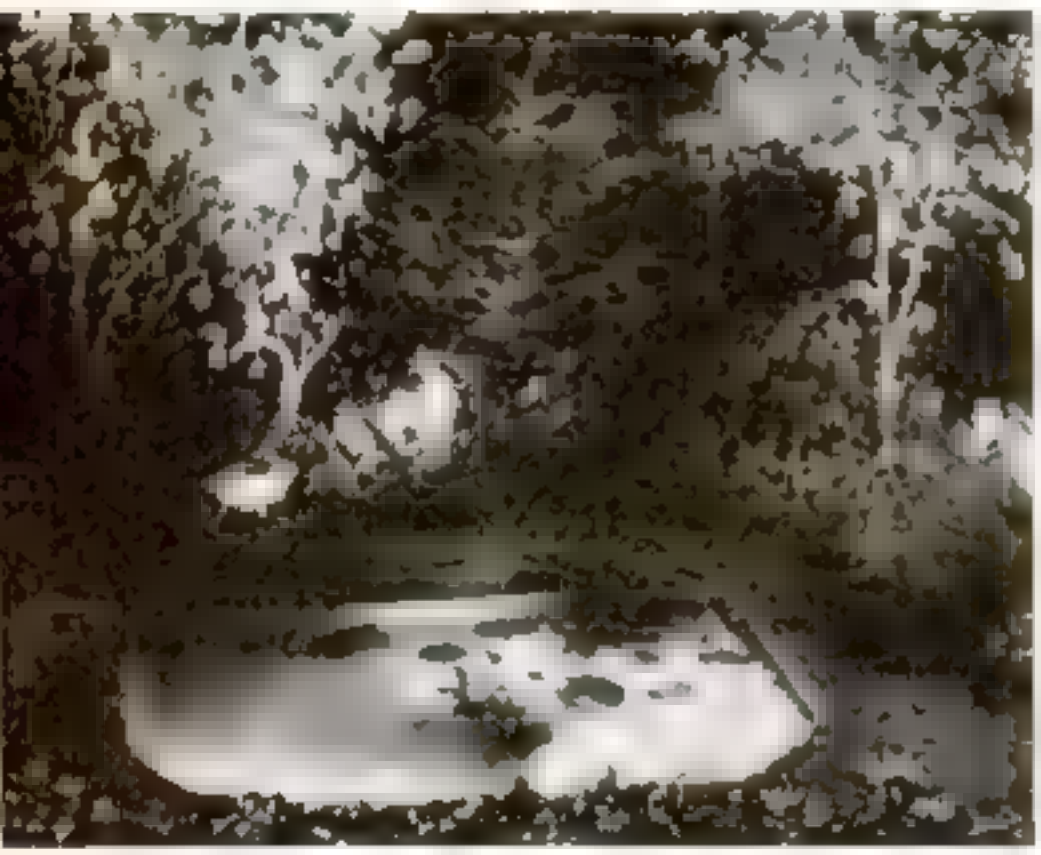
Permanent outdoor wiring is simpler than you think

Most local wiring codes allow direct-burial UF cable, which must be enclosed in conduit only where it leaves the ground. Outdoor outlets may be mounted on fence, stake, or tree.



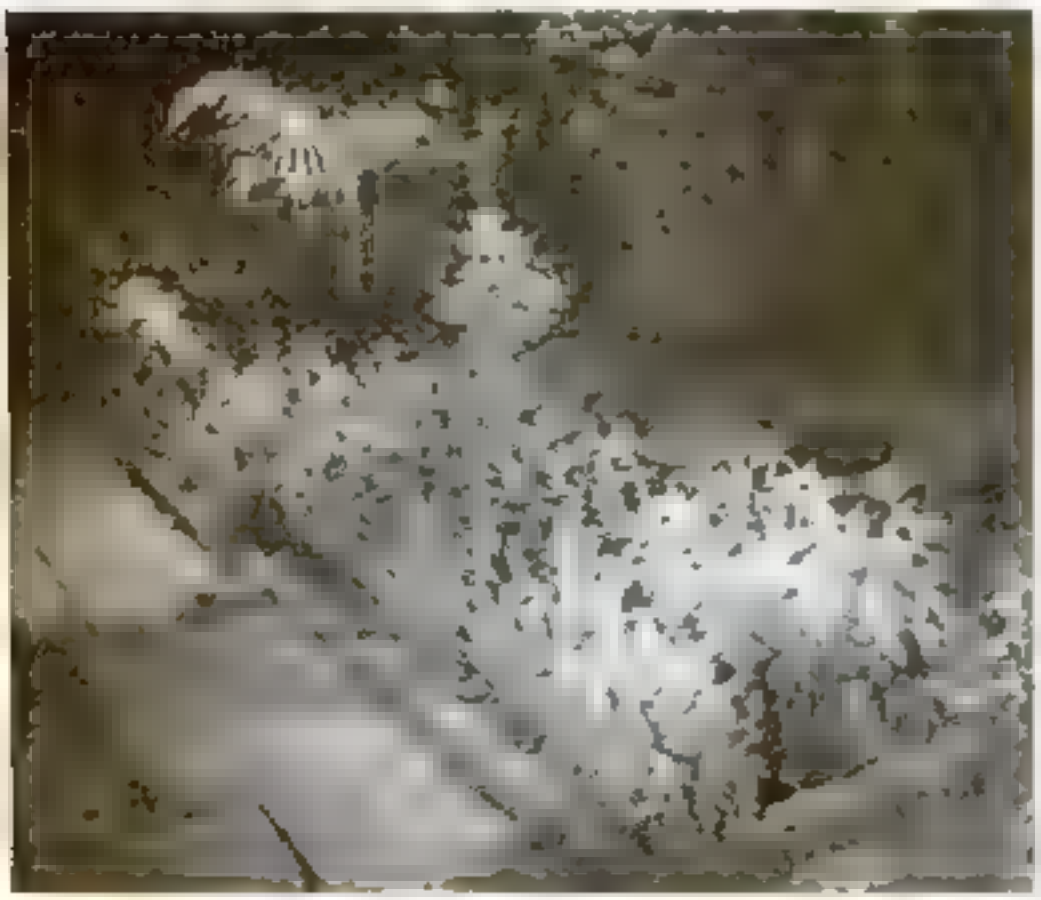


High-mounted floodlamps give wide spread of light with little glare. One above garage door lights driveway; one around corner lights path to house. Both are Westinghouse PAR bulbs.



Latex lily pad, floating among real ones, has small bulb clipped beneath. This GE appliance will light a pool 10′ in diameter. Plants around pool have small lights hidden in them.

Decorative down lights, spiked into flower border, illuminate plants as well as path. Low mushroom type in foreground is most popular. Both Westinghouse fixtures have weatherproof cords.



at the most hazardous spots, but space them so the circles of light overlap.

2. Post lights. You may need several for a long walk or a walk flanked by light-blocking planting.

3. Down lights (with shields to aim them) mounted 24″ to 36″ high along the edges of the walk. Space these not more than 16′ apart

4. Walk-level lights. Space them 6′ to 8′ apart.

5. Wall-mounted lights if a walk runs alongside a building, fence, or wall. Spacing depends on whether the lights are installed high or low.

Garden paths are lighted by the same methods. But they are used less frequently, and you can get by with less light.

How to light steps. No matter what you do elsewhere, fully light all outdoor steps. Install one or more down lights next to them, or light them from above with floodlights or post lights. Make certain that all treads and risers, as well as the top and bottom landings, are clearly outlined.

How to light a driveway. Use floodlights mounted high on the garage or in the trees. For ordinary use, light only the space in front of the garage. Use floods to illuminate a parking area, too. If possible, blanket the entire area (the light does not have to be intense) so that your guests can see to squeeze in and out of tightly packed cars.

How to light small pools. You need only enough light to warn the visitor that there is a pool. Conceal lights in the shrubbery around the edges. Or submerge a bulb in the pool. This looks beautiful, especially if the pool sides and bottom are painted blue or green.

You can use special underwater fixtures or ordinary 15- or 25-watt household bulbs in watertight rubber sockets hidden under the ledge of the pool. A clever gadget is a latex-rubber lily pad that floats on the surface and holds a small bulb below.

How to light swimming pools. Most people rely entirely on underwater lighting. But you may need overhead lighting if the ground or paving around the pool is hazardous or if you often play host to teen-agers.

One 300- or 500-watt underwater light recessed in the center of the deep-end wall, 12″ to 24″ below the water level, is adequate for the average small pool. Large pools may require additional lights in one of the side walls.

Underwater lights were formerly oper-

Dips after dark are safer in a well-lighted pool. Here, two lights are recessed on each side. Pole fixture, floodlit trees, and umbrella with bulbs inside cast glow over adjacent area.

ated at 120 volts, but because people have been electrocuted by these, there is now a switch to 12-volt lighting. In some areas, this is required by code. The lights are just as efficient as the old type

For overhead pool lighting, use one or two 150-watt floodlamps mounted about 12' above ground on posts or trees at the ends or opposite corners of the pool. These give good illumination; but for pleasanter appearance, you may prefer to ring the area with low down lights. Or you can conceal bulbs (in weatherproof lamp holders) in the surrounding shrubbery.

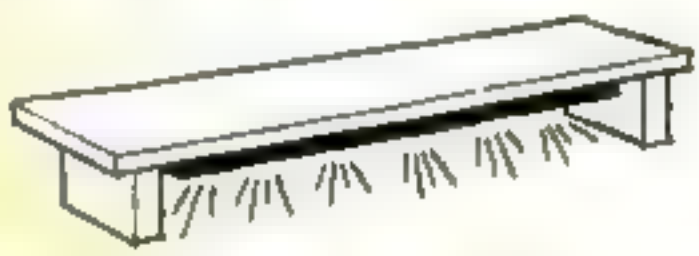
How to wire your yard. Before running permanent wiring to your outdoor lights, you should determine exactly where the lights are to be placed. This calls for some experimenting

Use weatherproof cords (Types S, SJ, ST, or SJT) with molded-on, weatherproof plugs and sockets. Do not string or connect cords or screw in bulbs when the ground or foliage are wet. If you leave the experimental installation in place for any length of time, tape the joints between male and female plugs and drape the union over a stick or stone to raise it off the wet ground

You may need new circuits, a new fuse box, even a new service entrance panel. For the wiring itself, use Type UF underground cable with No. 12 wires or larger. All outdoor electrical boxes, outlets, switches, and fixtures must be weatherproof. ■■

Don't like bare bulbs? Here are ways to hide 'em

Hung from overhead branches, down lights blend into landscape. Base of wren house (left) houses floodlight. Homemade fixture (center) is tin can with bottom cut away, fitted with porcelain socket. Commercial type (right) has barklike exterior; inverted, looks like stump.



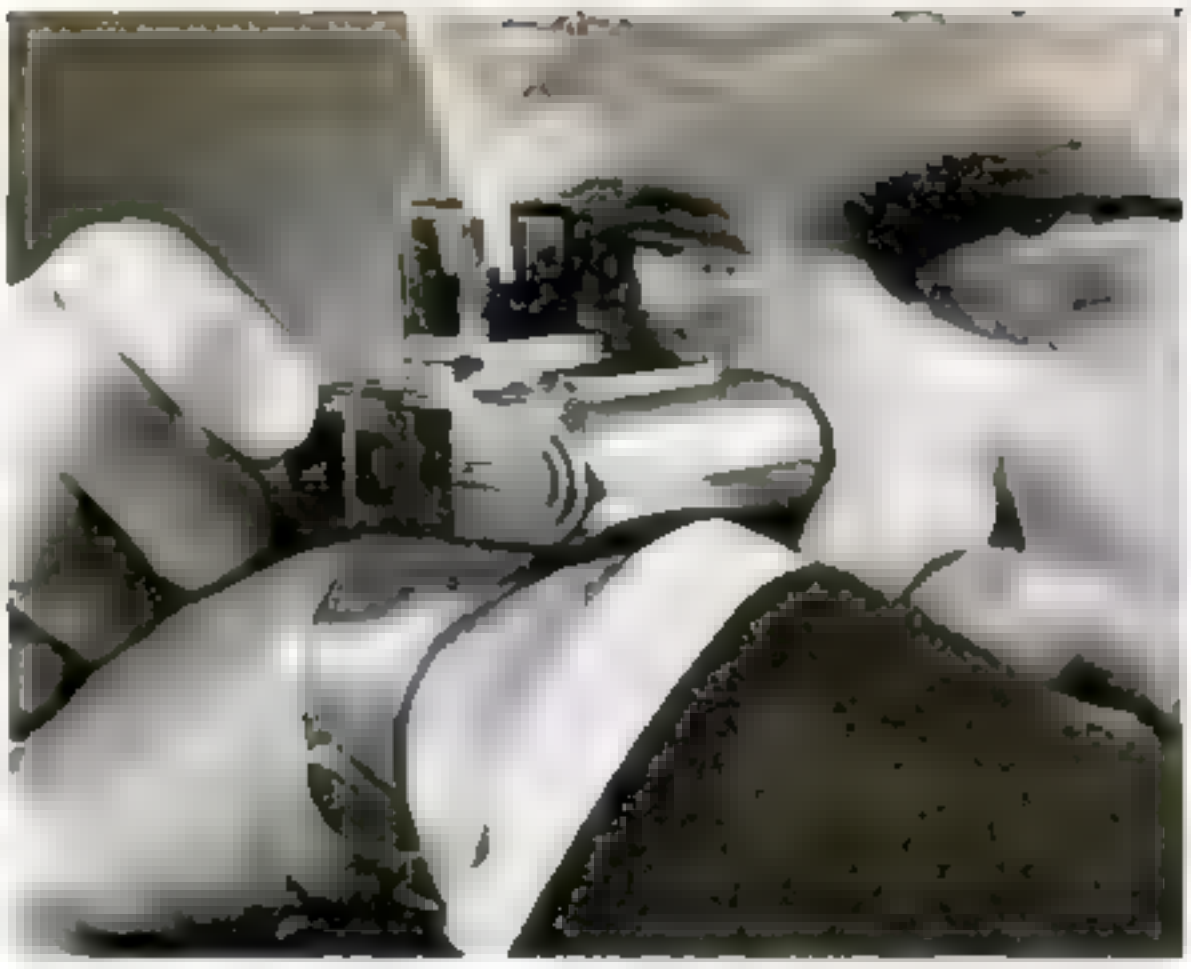
Path-side bench is light source: Fasten a channel for a fluorescent tube underneath.

Shields for ground lights can be plain or fancy. Animal silhouette (left) can be cut from metal or board; attach a spike and broom holder to support watertight socket. Tin shield (center) is painted green, pushed into ground. Or cut out rear of watering can (right) for floodlamp.

what's new

..PHOTOGRAPHY

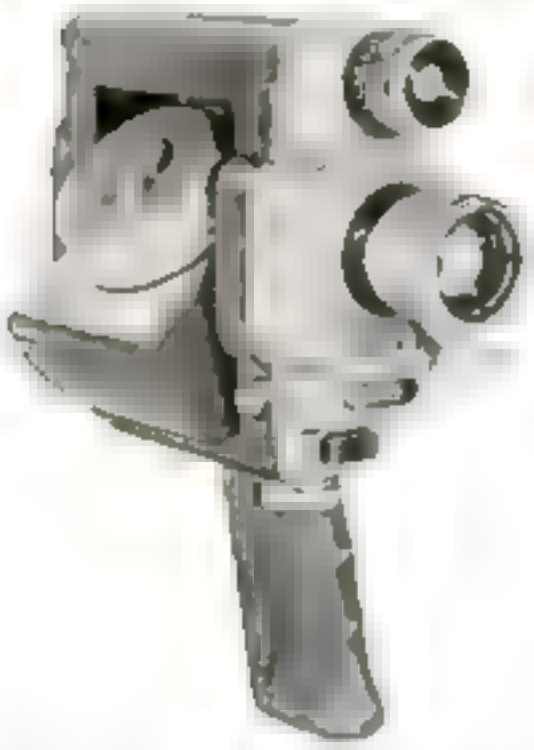
Wrist strap for unobtrusive candid shooting



A new accessory lets you wear the Tessina subminiature like a wrist watch—which is appropriate, since the camera is made by Swiss watchmakers. It weighs under six ounces, is smaller than a pack of cigarettes, uses any 35mm film (loaded in special cassettes) and gets 2½ to three times more shots per roll than a standard 35. It features reflex or sports-finder viewing, an *f* 2.8 lens, speeds to 1/500. Pressing the shutter release also advances film, cocks shutter for next shot. Camera $169, strap $3.95. Karl Heitz, 480 Lexington Ave., NYC.

Flip-over film chamber eliminates rethreading

The 8mm movie camera below gives you a full 50-foot run without rethreading. You load roll film in the usual way, but after shooting 25 feet, you needn't open the camera to reverse the spools. Instead, you pivot the chamber upside down and expose the other half of the strip. The Dual Run also has an *f*/1.8 manual zoom lens (11.5 to 32mm), a cadmium-sulfide meter, and through-lense viewing. $190. Sekonic, 130 W. 42 St., NYC.



You can take it with you—for remote control

The pushbutton panel of the Versatile P-909 movie projector can be slipped from its socket and carried anywhere in the room for remote control. You just attach a cord of any length, and the illuminated panel works exactly as it does when in place on the machine. You can start, stop, and reverse the film—or freeze the action to project a bright still without danger of scorching, thanks to a new heat-absorption filter. The projector is self-threading and has a zoom lens. $150. DeJur-Amsco Corp.

Kit for Home Color Printing

EVER get a smug feeling that you've mastered darkroom techniques and need a new world to conquer? Try color printing. You can't use the excuse that it needs expensive equipment and professional training. A new color-print kit packaged by FR Corp., 951 Brook Ave NYC 51, puts you in business for $12.95 If you've got a fairly complete black-and-white darkroom (enlarger, timer, trays running water), the kit has all the extras you'll need to tackle color.

The kit includes 20 sheets of a 3½"-by-5" paper (with three emulsion layers), six enveloped powders for mixing a quart each of three solutions; a set of blue, green, and red color filters with their own holder to clamp on your enlarger; and a nifty calculator in which you expose a test strip to find what three exposures each color negative needs.

Working blind. There's also a diffuser gel you fit over your safelight. You're likely to find it too dense to be of much use until your eyes adjust to the dark.

You use only three trays, as in black-and-white printing. After five minutes in the developer, a one-minute wash, and another minute in the fix, you can turn the room lights on! Two more minutes in the fix, a five-minute wash, and you're ready to bleach the print for 10 minutes before giving it the final wash.

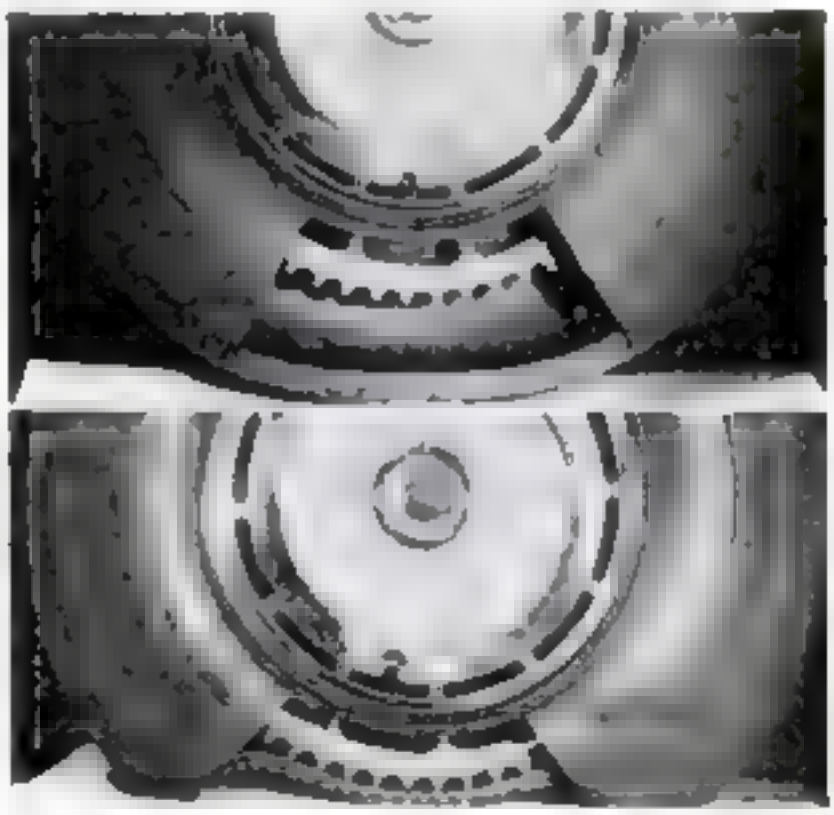
It's a tricky process. My first print—a boating scene—had a pronounced blush cast, though it was exposed through the "goof" (Infrared 88B) filter supplied to correct this tendency of Kodacolor negs. So I consulted the kit's print-corrector chart and made the recommended adjustments, up and down, in my second series of exposures. This time the scene came up an eerie green, as if the boat were under water

Further tries indicated that success depends on getting the feel of the system You may have to write off your first couple of sessions as education. But the kit at last completes the home color process, putting you in charge from the click of the shutter to the finished print.—*Alfred W. Lees.*

what's new .....for your CAR

Folding bag for water or gas

Now you can always have a container for emergency water or gas on hand in the car. A new plastic bag with a non-drip spout rolls up and fits in the glove compartment. It holds 1½ gallons. Fairbanks Company, P.O. Box 74, Sugarhouse Station, Salt Lake City, Utah, sells it for 35 cents.



Tire inserts serve as hidden spare

These tubeless-tire inserts give protection from the hazards and inconveniences of blowouts and flats, according to the manufacturer. Two semicircular aluminum rails bolt to each wheel rim inside the tire to give support, and let the car be driven for miles on a flat. A set costs $17.50 to $25. Posi-Trac Rail Co., 711 Taft, Houston, Tex.

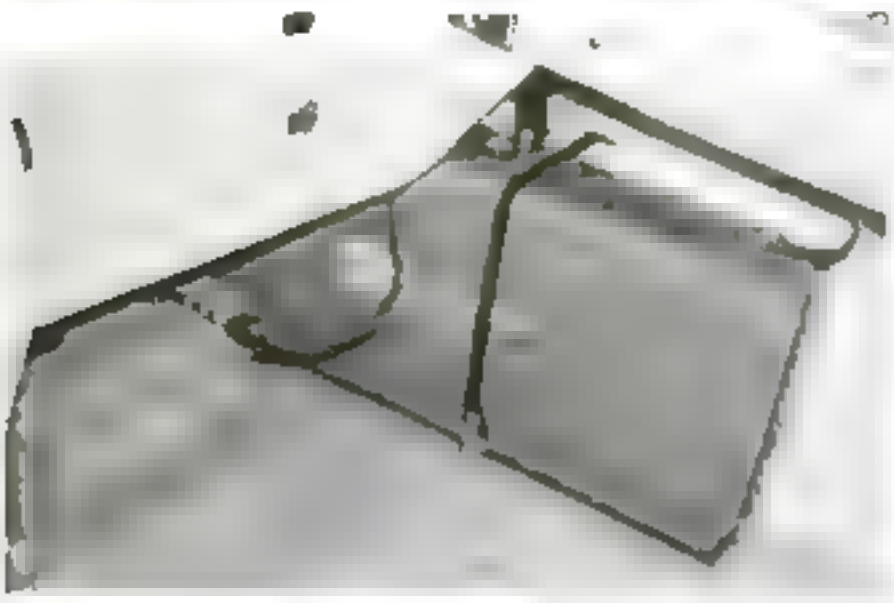
[*Continued on page 184*]

what's new

.....BOATING

Elevators Keep Boat on Even Keel

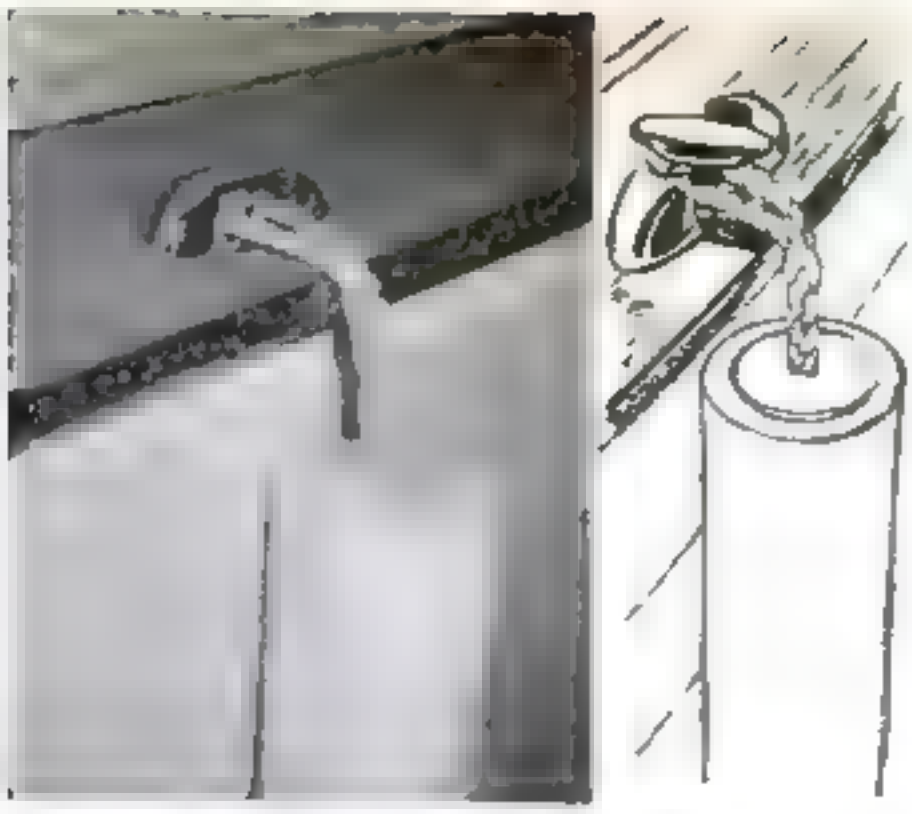
These tail planes, fastened to a boat's stern, work something like the elevator on an airplane. Forced downward by compressed gas, the hinged planes automatically adjust their angle to lift the stern so the boat planes level. This increases speed, eliminates pounding and porpoising in choppy water. It also gives water skiers a smoother start. Tilted farther down, the planes slow a boat for trolling or emergency braking. Four sizes of Plane-O-Matic elevators fit inboards or outboards up to 30'. $125 to $280. Sea-Trim Corp., 1315 Western Ave., Plymouth, Ind.



Tapered tanks for extra fuel supply

Tucking a supplemental tank under the gunwale greatly increases the range of a six-gallon outboard. Tapered to save space, tanks can be filled from outside while boat is on a trailer or docked. Tanks can also be set in a sloping motor well.

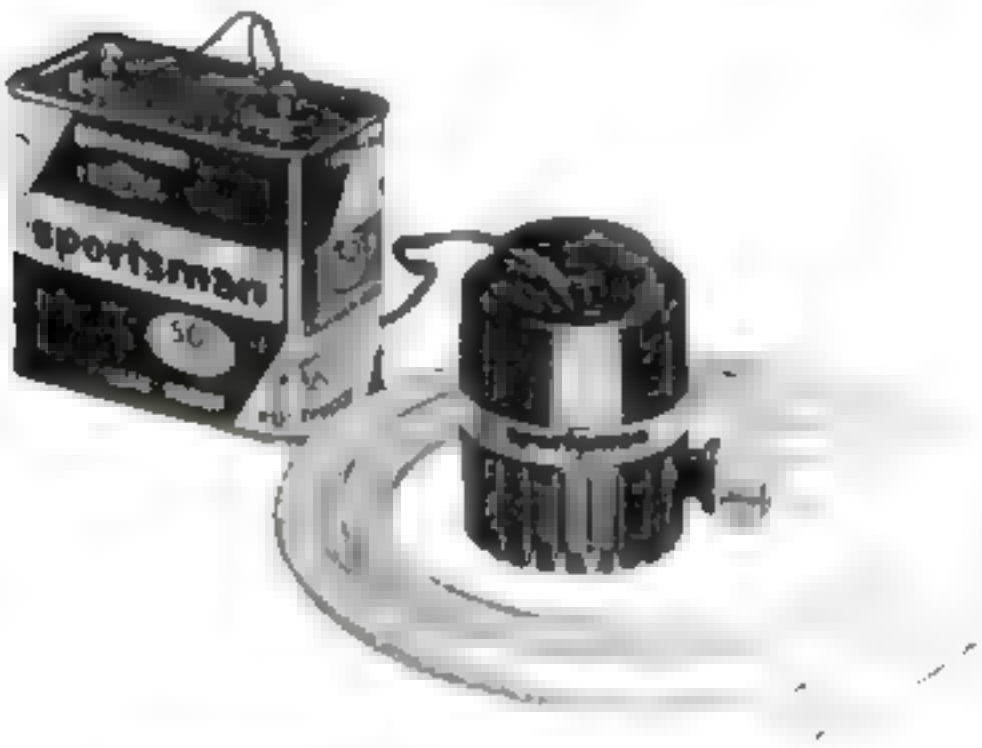
With mounting cradles, the 12-gallon size is $55; the 18, $67.50. Fill-pipe kits run $15.50 in chrome, $22.50 in bronze. Tempo Products, 2062 E. 70th St., Cleveland.



Snagproof deck cleat locks line

This chromed, spring-loaded cleat for motor or sailboats prevents snagging of lines, sails, or clothing—eliminates tying. The center bar pivots open to take the line, closes to lock it in the cleat. Channels take lines up to ⅜". Set of two is $3.50 (four, $6.75) postpaid from Safety Boat Cleat Co., 644 Diversey Parkway, Chicago.

▶▶▶You're ready for emergencies afloat if you pack a distress kit containing Dayglo-lettered appeals for such needs as gas, first aid, and tow—plus a signaling device. Price is $2 from Pilgrim Industries, 393 Lower County Rd., Harwichport, Mass.



Boat bailer is battery operated

Though powered by a six-volt battery, the MB-4 bailer is completely submersible. The battery shown has a leakproof, rustproof aluminum case; bailer will also operate on an auto or marine battery. A sturdy plastic housing encloses motor and a pump equipped with standard hose threads. $24.95. Ray-O-Vac Co., Madison, Wis.

Saw rig for hard-to-reach spots

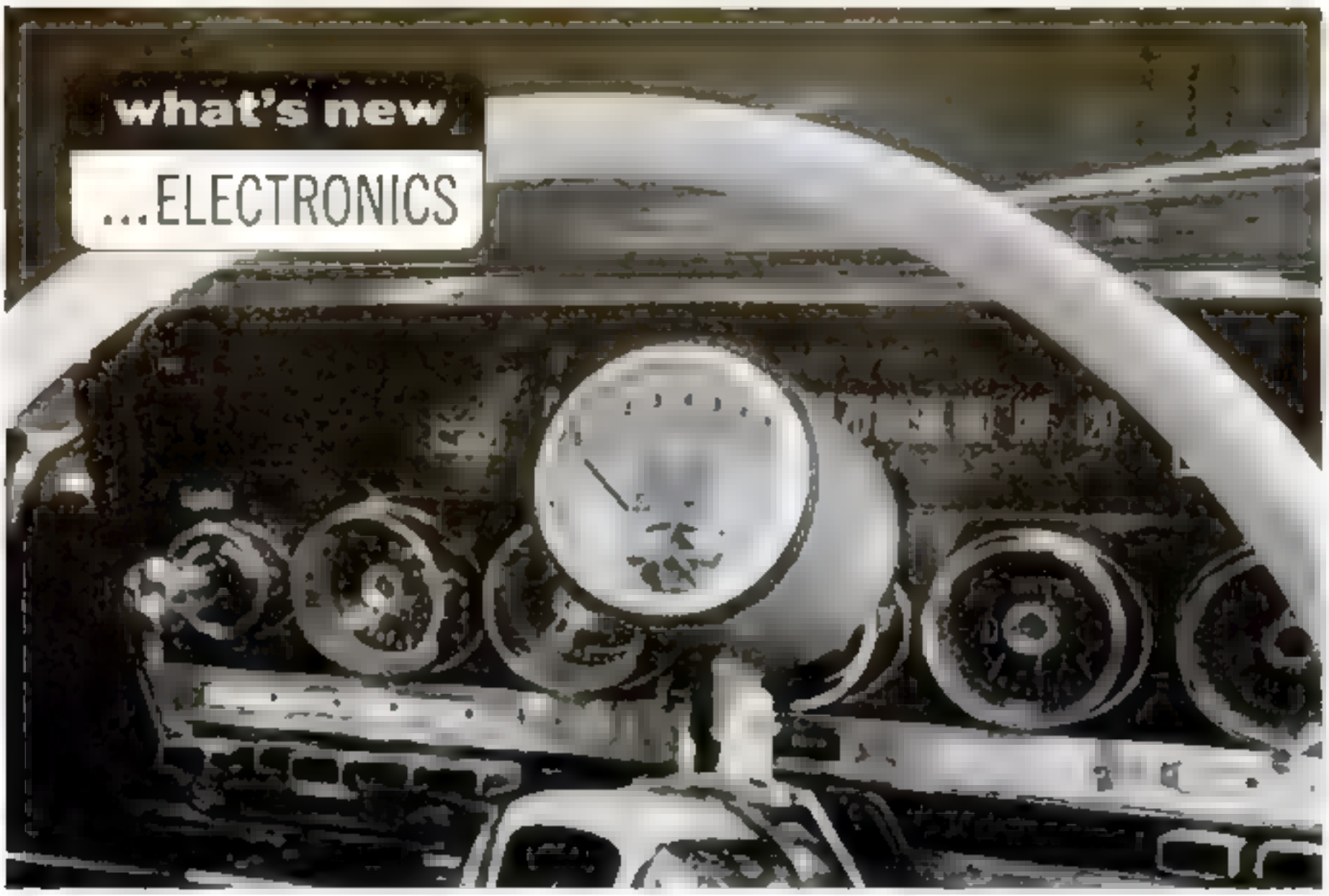
Chuck this saber-saw attachment in a portable drill or flexible shaft, and you can cut close to a wall or floor, through material up to 4¼" thick. Reversible blades are usable right- or left-handed, will also cut metal. Saw, with six assorted blades, $14.75. Grip-Tore Tools, 17480 Shelburne Way, Los Gatos, Calif.

Steel tape for inside measurements

You can't goof on inside dimensions (such as window openings) if you can set your tape in for an exact reading. The first 2" of Disston-Carlson Roto-End tapes swivel to the side to compensate for the case width—there's nothing to add to the actual reading. The 10' size is $3.50, 12', $3.75, 16', $4.20.

▶▶▶Corner-patching cement or plaster is simplified by a new precision-angled tool-steel blade. Made by Howard Hardware, 250 Elizabeth Ave., Newark, N.J., the Korner Tool sells for 50c.

[Continued on page 185]



Do-It-Yourself Tachometer

CARS, boats, planes, karts, industrial engines—this transistor tachometer in kit form fits them all.

It works on 1- to 16-cylinder four-cycle engines and 1- to 8-cylinder two-strokes. It also runs on 9 to 32 volts. With a magneto or six-volt ignition system, an auxiliary battery (not supplied) is necessary; a transistor-radio battery provides enough power for several months. Calibration for the various engine types is via ordinary house current.

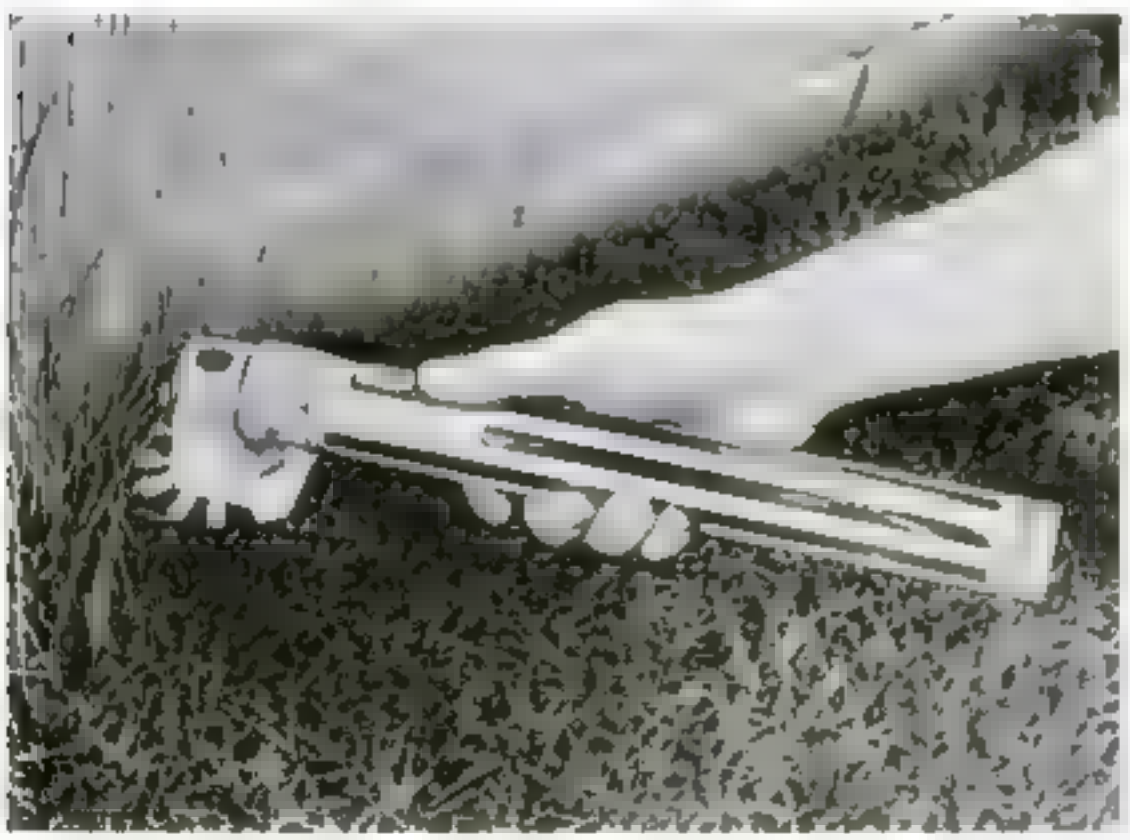
The Knight-Kit tachometer can be assembled in a few hours with only a soldering iron, long-nose pliers, diagonal cutters, and a screwdriver. Its illuminated dial registers up to 8,000 r.p.m. The manufacturer claims a three-percent accuracy throughout the r.p.m. range—regardless of normal variations in temperature or voltage.

A red pointer can be set at any speed to show at a glance the optimum shift point or maximum safe r.p.m. before valve float occurs.

The assembled tachometer can be secured temporarily to the steering column with an adjustable clamp, or it can be bolted permanently on top of or below the dash. Allied Radio Corp., 100 N. Western Ave., Chicago, sells the kit for $24.95.

Thermoelectric refrigerators

These two refrigerators need no motors, compressors, or refrigerant. The cold comes from thermoelectric panels made of pairs of junctions between two types of semiconducting materials. When electricity flows in the circuit, one junction absorbs heat; the other generates it. So one side—within the cabinet—gets cold. The two-cubic-foot model above, made by Norge, will sell for around $600. The portable at right, made by Whirlpool, will work off an auto battery as well as home AC. Called ThermoMagic, it sells for around $200.



Flashlight batteries power grass clipper

The cordless lawn clipper above runs on five standard D-size batteries. It has double-edge rotary blades you can flip over or replace when dull. They cut against comb fingers that protect them when pushed against a wall or tree. The clipper is 15" long, weighs 1½ pounds. Without batteries, it costs $12.95 at Burgess Vibrocrafters, Grayslake, Ill.

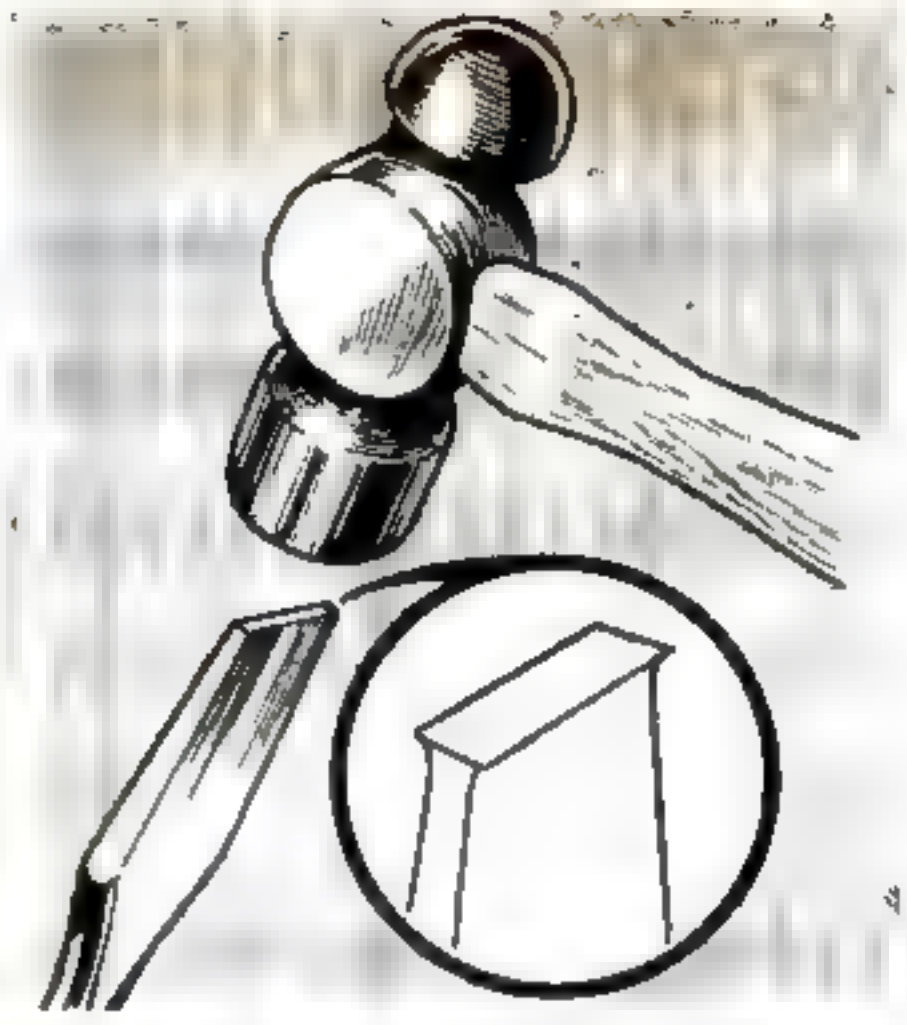
Electric toothbrush has rechargeable battery

There's no cord to get in the way when you use the automatic toothbrush below. Its nickel-cadmium battery is kept fully charged simply by storing the power handle in a plugged-in wall-mounted holder. GE includes four interchangeable brushes in the kit, which is priced at $19.95. Extra brushes cost 69 cents each

Short Cuts and Tips FROM PS READERS

Spray can subs for laminating machine

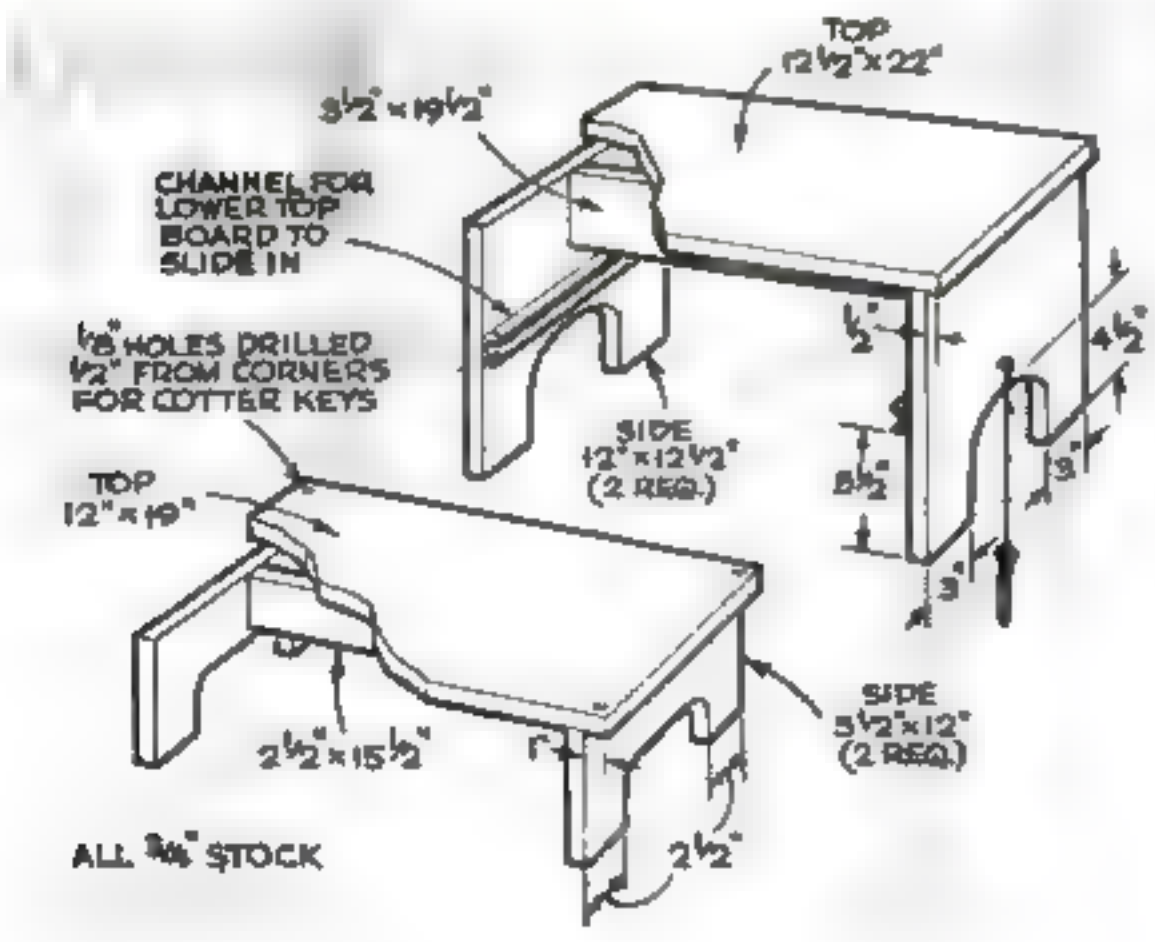
The easy way to seal pocket calculators, wallet identification cards, photos, and small documents in protective plastic is to coat both sides with clear acrylic spray from a pressurized can. It offers much the same protection from wear and common solvents as heat-laminated plastic sheets. —*Ken Murray, Colon, Mich.*



Blunt driver blade locks in screw slot

Driver bits rarely fit screw slots snugly enough. The play tends to enlarge the slot still more by rounding its shoulders, and the smooth-tapered blade lifts out, marring screw and work. To avoid this, I blunt the blade tip as shown. The lips help it get a better bite, deep in the slot. —*Hugh Lauffer, Warren, Pa.*

▶▶▶ You can grind the edges of plate glass quickly by using a portable belt sander. A #40-grit aluminum-oxide belt cuts smoothly with a minimum of pressure. Place the glass on a smooth surface with the edge extending slightly, and pass the sander from left to right along the edge at a 45-degree angle. Don't oversand in one spot—the glass may crack from excessive heat.—*Louis F. Black, Cedar Rapids, Iowa.*



House-trailer steps stack for storage

The threshold of my house trailer is too high to step up onto from ground level. I needed a sturdy two-tread step that was compact enough to store inside the trailer, yet easy to set in place.

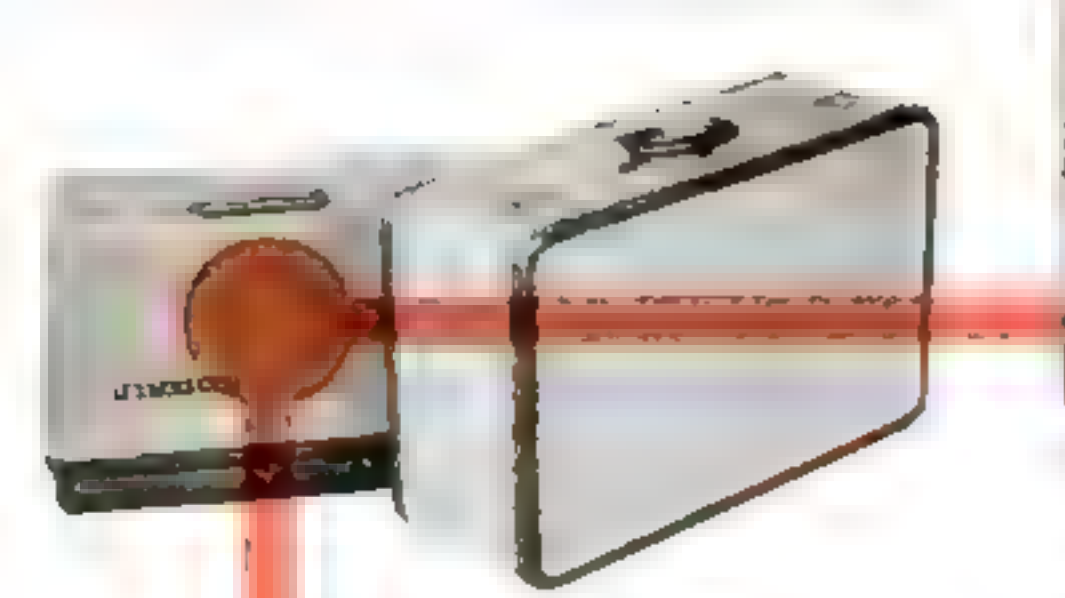
I designed one in which the bottom tread slides under the top one. When extended, it's locked by cotter pins inserted through the aluminum track and into holes in the back corners of the tread. Retracted, the step is held with the same pins in front-corner holes. —*C. A. Alexander, El Cajon, Calif.*

Back-Porch Store-All

EACH time Bern Stromquist of Toronto put his car away, he kept his fingers crossed. It had become a ticklish maneuver to edge it into the garage, past the lawn roller, mower, wheelbarrow, tricycle, rakes, and shovels. After one such squeeze, he glanced at the waste space under his platform porch.

He enclosed this space with 4" cedar siding, adding a tall closet opposite the stairs for long-handled yard tools. It also has shelves for small tools and flowerpots, and during the winter it stores the patio furniture. The roof slopes slightly for drainage, and the suspended floor is ¾" exterior plywood. The cupboard beneath the porch has a double door wide enough to roll the barrow through.

Framed plywood panels set between the railing posts were the final touch.—*Roy Webber.*



It's a portable drill press. The motor slides in a frame that keeps drill square to work. Entire outfit fits into small case at left

A personal use report on

The Workshop in a 'Suitcase'

Portable tools or bench tools—you have your choice. And a low-voltage adapter fits them to battery power

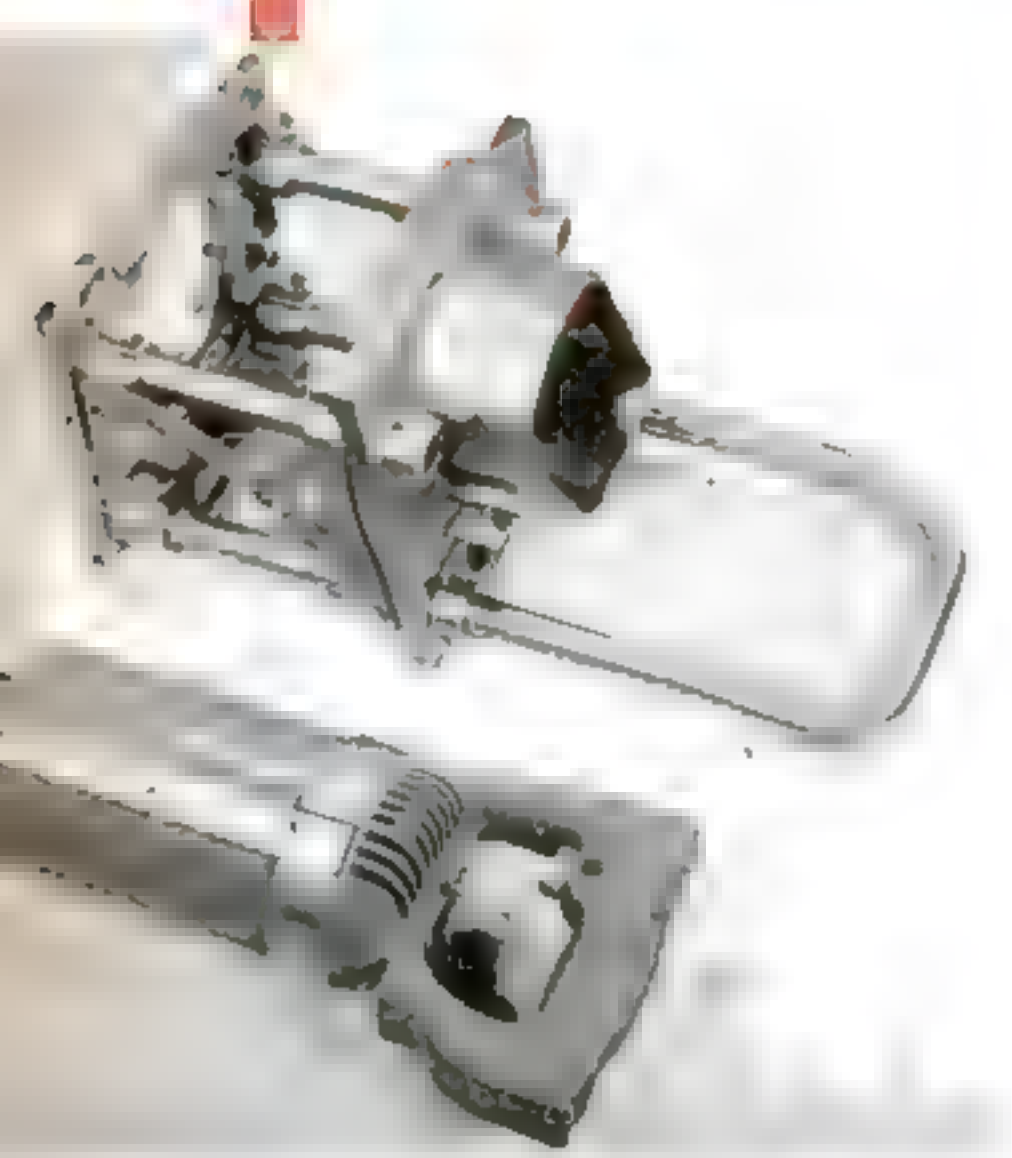
By R. J. De Cristoforo

THEY'VE finally done it—put a whole range of woodworking power tools in a suitcase. The outfit is ingeniously engineered around a gutsy ½-hp. drill. A frame in which the drill slides keeps the bit at right angles to the work, whether you bring the work to the drill or the drill to the work. This is a concept that will make many woodworkers flip, for the result amounts to a *portable* drill press.

Larry Pugsley, inventor of Porta-Shop, started with that basic idea. Then he went beyond and developed a whole portable shop—table saw, jigsaw, disk sander, shaper, drum sander. Each one is either a stationary tool or a portable tool, just as you choose. A low-voltage adapter will be available so you can work far from electric outlets if a car or a storage battery is handy.

Universal Electric Corp. (Owosso, Mich.) makes the Porta-Shop, including the ½-hp., 6-amp. motor, originally developed for Navy radar. Its high torque came through on all our tests; it will whimper only if you really try to choke it.

As a drill press, the tool's a dilly. No point in comparing it with a conventional drill press; it just doesn't work that way. You slide the drill in the sleeve—a full 6"—



Heart of the Porta-Shop is a husky ½-hp. motor with handle (a conventional portable drill) and an ingenious frame to hold it.

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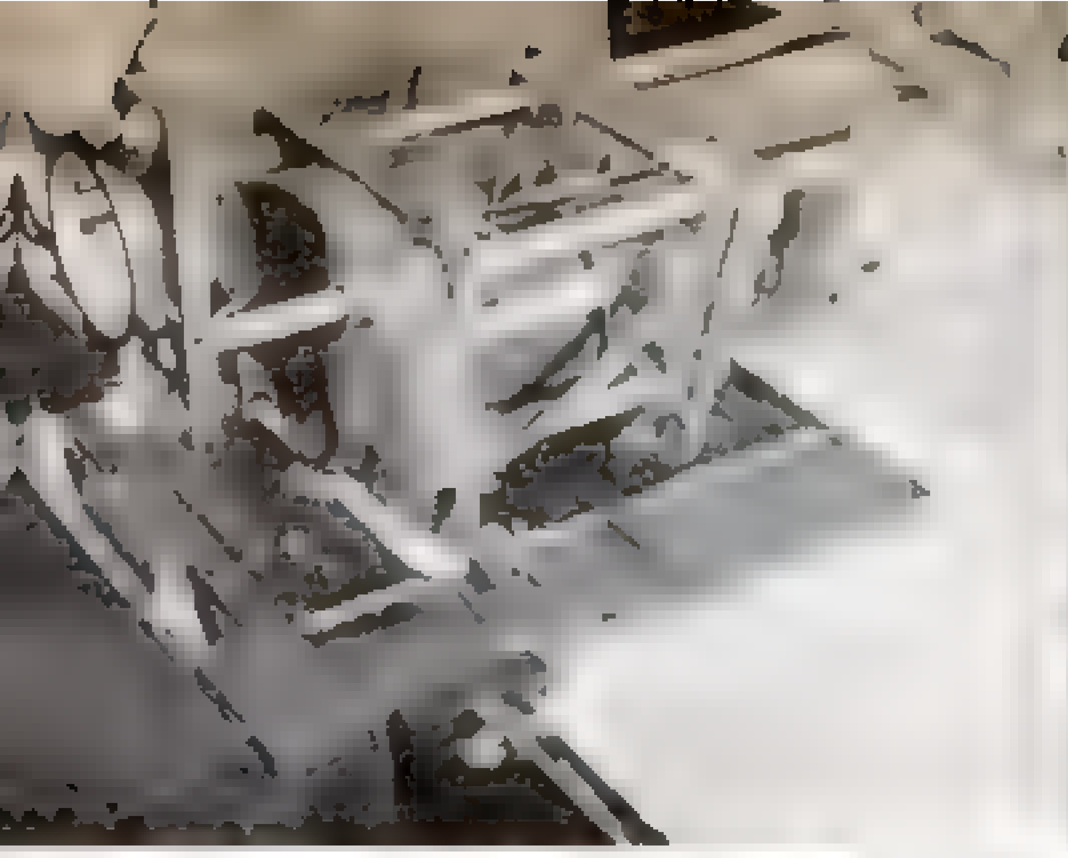
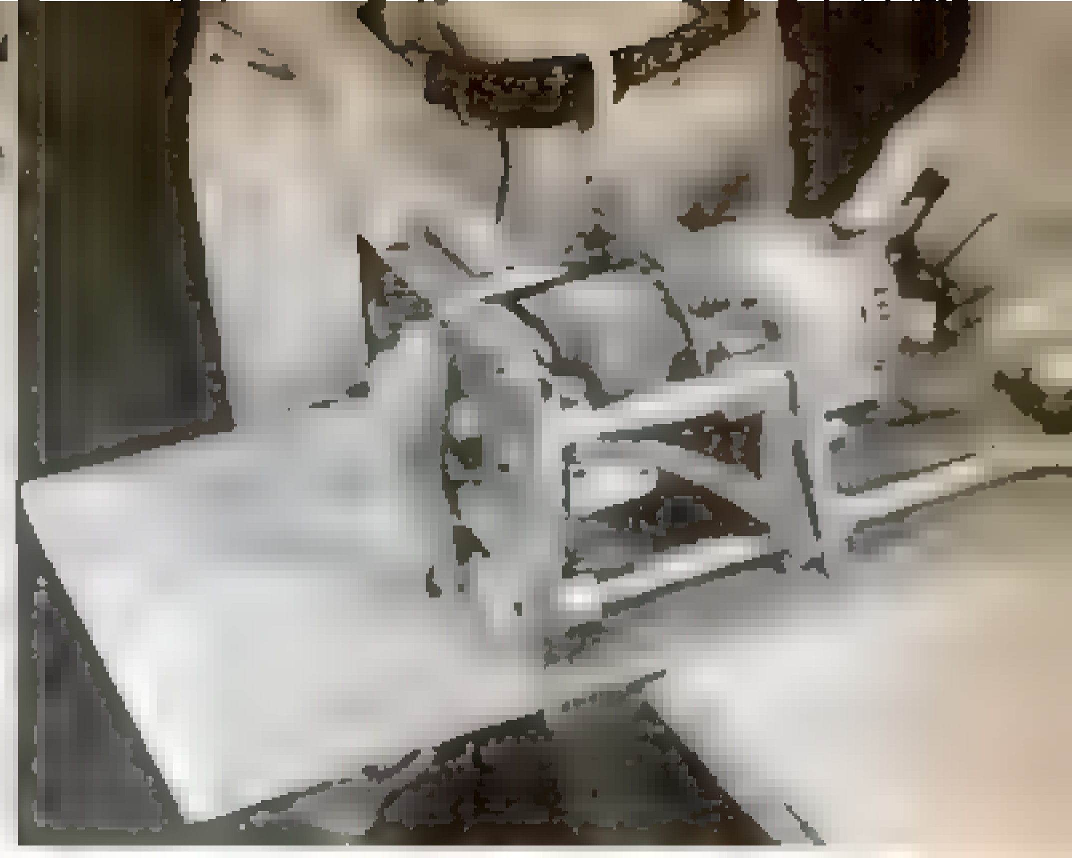
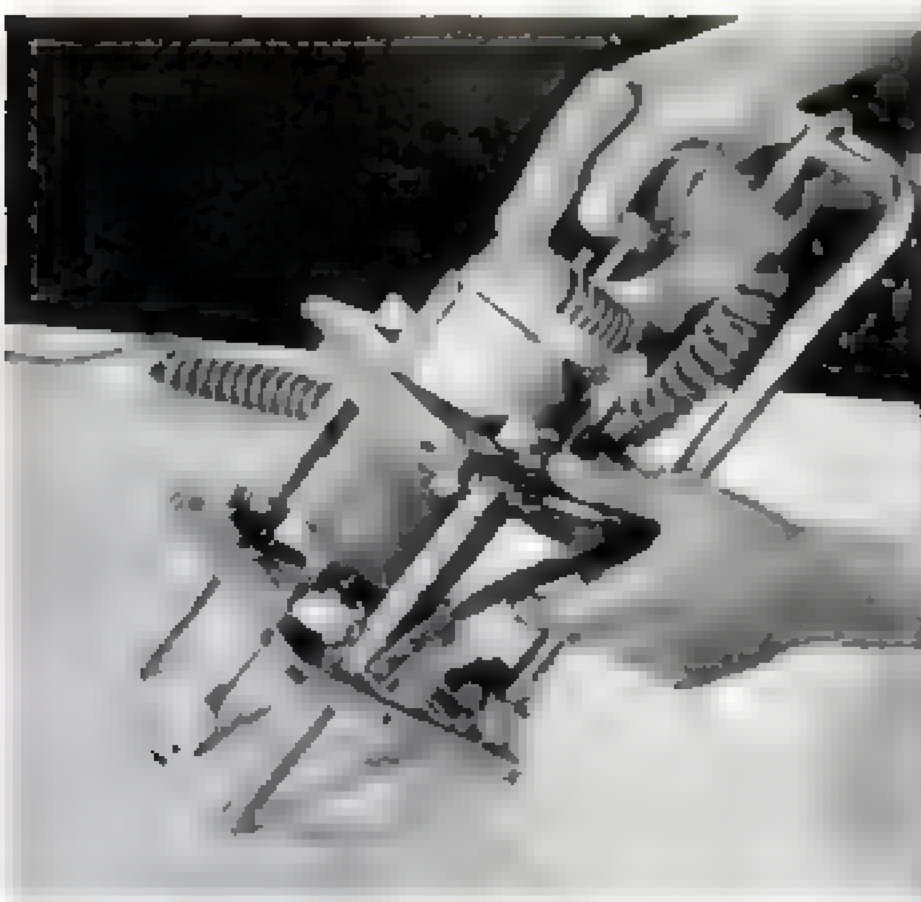


It's a portable saw. For this the saw table becomes the sole plate [illegible] You clamp the work and use both hands.

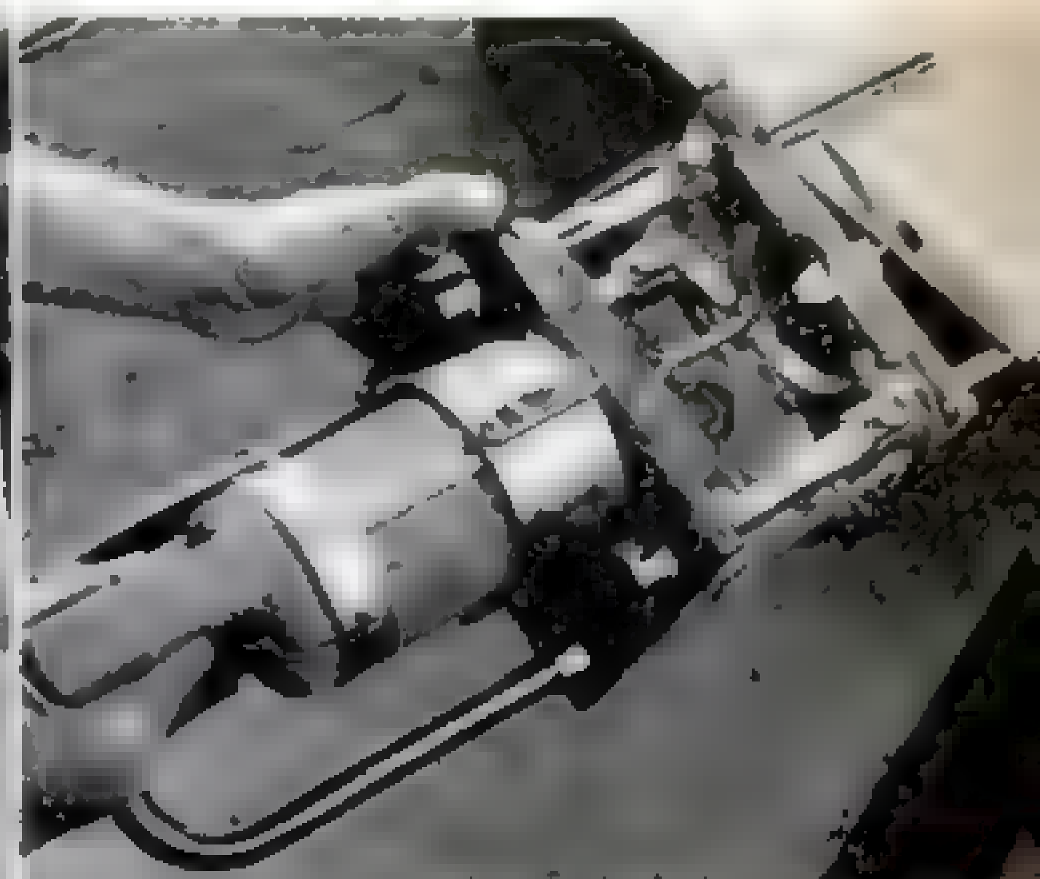


It's a portable saber saw when table is removed. The tool is light: motor case is aluminum; frame is [illegible] rust stainless steel.

What you can do with the tool as a drill press



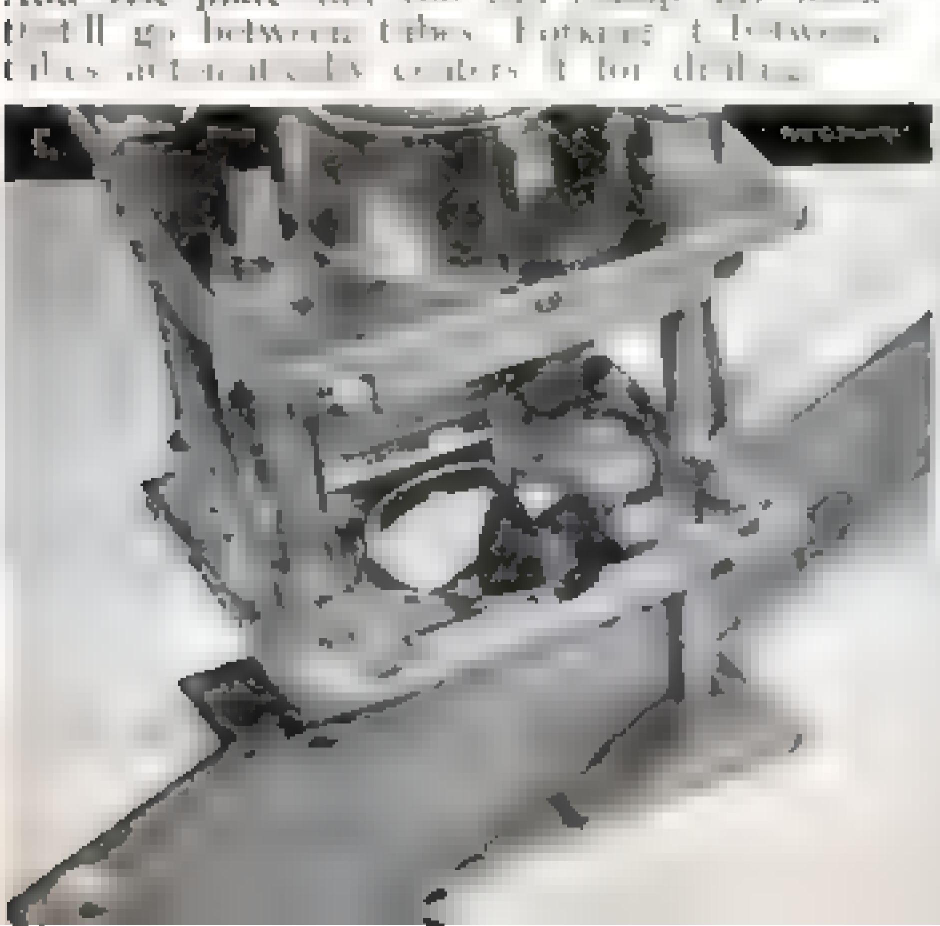
Using extension tubes, you can tilt it for simple or compound edge drilling. One of the tubes is marked for common angle settings.

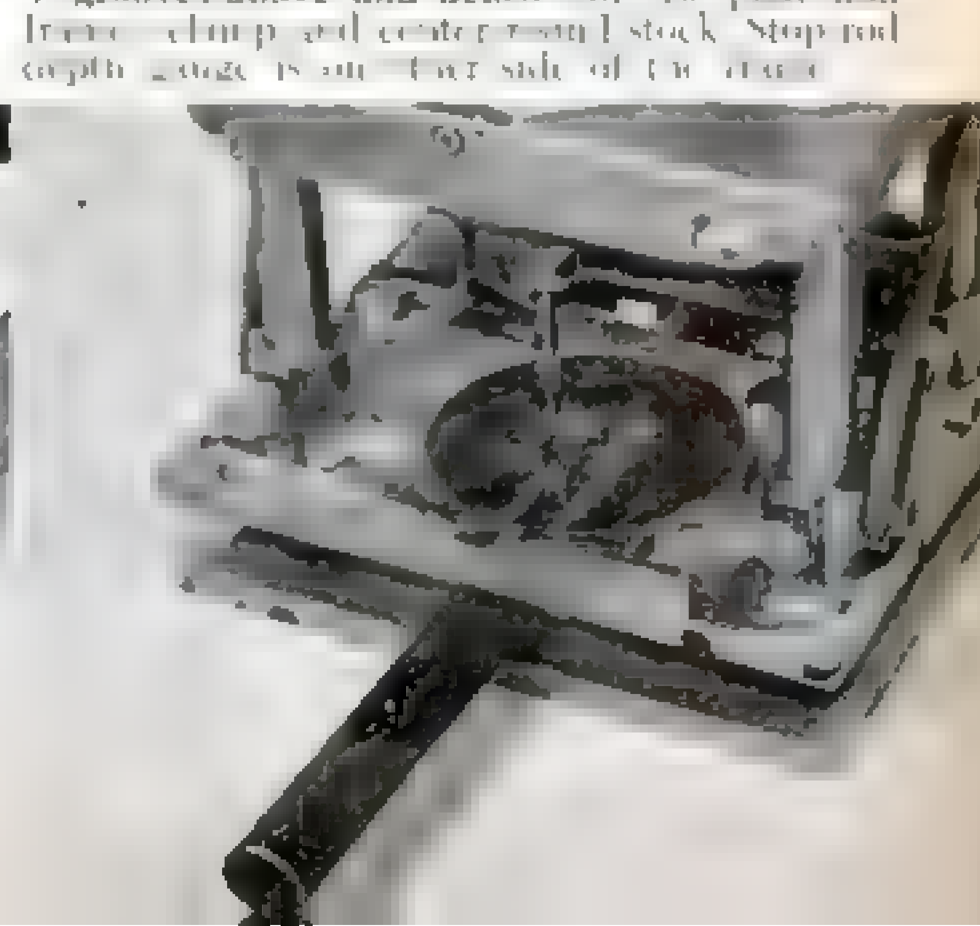


Center-drilling edges for dowel joints is a cinch. Just fork the extension tubes over edges. The drill shows in the [illegible] frame.

Add vise plate and you can clamp any work that'll go between tubes. Forcing it between tubes automatically centers it for drilling.

V grooves above and below on vise plate and frame clamp and center round stock. Stop rod depth gauge is on [illegible] side of the frame.





instead of levering out the chuck. The frame assures perpendicular drilling whether the plane of the work is horizontal, vertical, overhead, or at an angle. Slip on the vise plate and anything that will fit between the tubes is automatically clamped. Substitute two stainless-steel tubes for the vise plate and you're set for automatically centered edge-drilling anywhere

The saw table can be attached at right angles to the drilling axis and the fence used as a stop for drilling holes in identical positions on several boards, or along a common centerline. For any of these jobs, there's a stop rod to control hole depth.

Slip the drill out of the sleeve (by loosening a single knob) and it can be used like a conventional portable drill. Its power is more than ample—its only drawback is too much speed (at 3,500 r.p.m.) for some jobs. Example: drilling large holes—beyond ¾" diameter in steel and 1" in wood.

The table saw is a tilting-table design. When used as a stationary tool, it should be set near the end of a bench to leave clearance for long stock on cross-miters. Projection of the 7¼" blade at 90 degrees is 1⅝", adequate for two-by-fours. But at a 45-degree tilt the saw doesn't quite cut through a two-by-four. (This may be remedied on future production models.) However, by removing the slim table insert, I could mount an 8" blade for that cut

The 4½" space from the front edge of the table to the blade is good support for a two-by-four, but for a two-by-six it's best to reverse the miter gauge

The miter gauge fits nicely in the table grooves and the grooves checked out parallel to the blade. Crosscut and miter operations proved satisfactory, the blade cutting

It's small but includes all major elements of a table saw

as easily as any 8" or 9" table saw. Because there are no auto-stops on gauge or table protractor, you are well advised to check all settings before cutting

Other drawbacks? You turn the motor in the sleeve for depth-of-cut adjustments, but the action is limited to about ⅝". This means that at its lowest point the 7¼" blade projects 1⅜". A 5½" "grooving" blade is provided for repeat-pass dado cuts, but here, too, the depth-of-cut adjustment is not sufficient to get the blade under the table surface—maximum projection is ⅞", minimum ¼".

The necessarily small fence did not square up perfectly and no adjustment is provided to make it consistently accurate. I have the feeling that quality control during manufacture is intended to eliminate alignment adjustments, since none are provided. Alignment remained fine during the entire test period.

You have a portable saw, if you take a dozen seconds to add a vise plate and guard, then flip the tool over. You must clamp small, movable jobs.

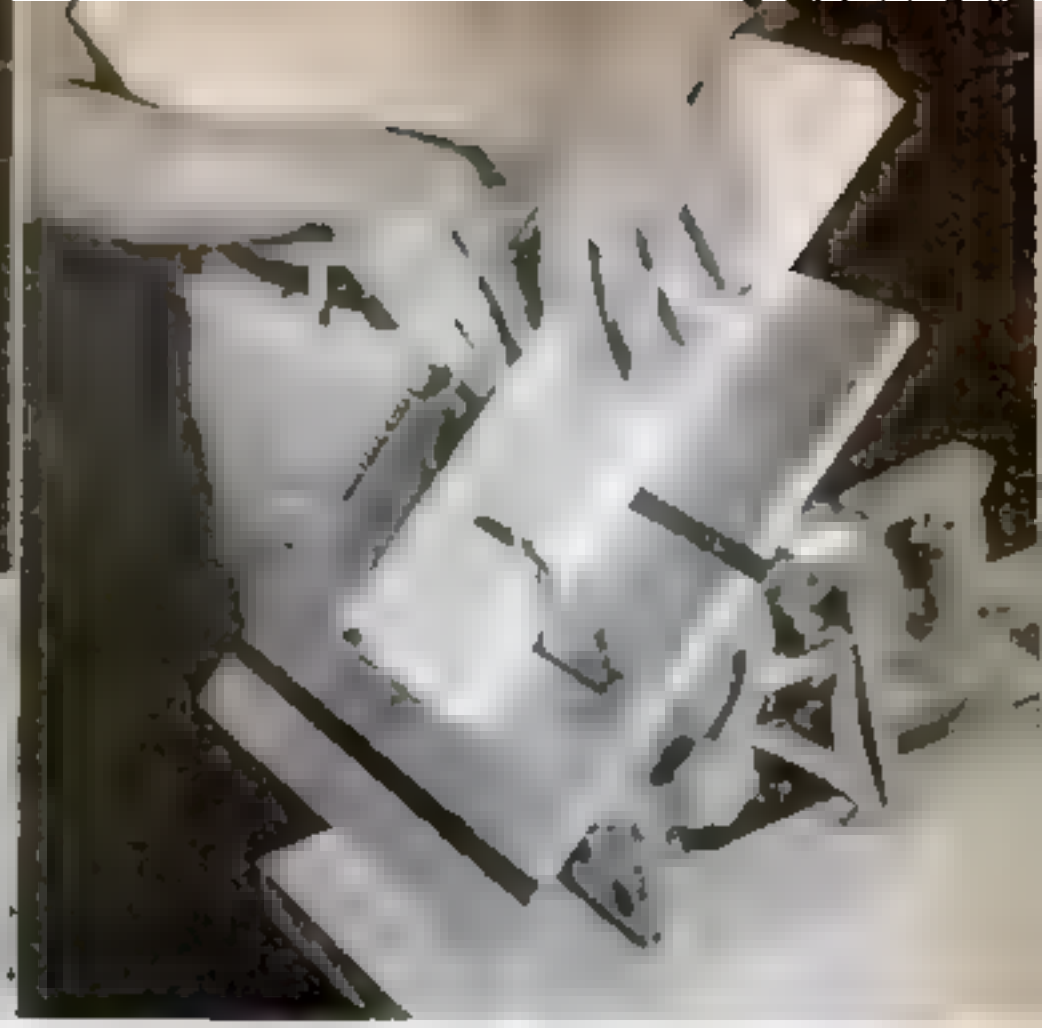
As a jigsaw, the setup is essentially the same as for the table saw except that you substitute a right-angle-drive chuck to grip saber-saw blades. Here, the shaft locks in the chuck, the body is secured against the bottom of the frame. The arrangement is rigid and speed is good, but since the blade is locked at one end only, you can't do the fine fretwork of a regular jigsaw because you can't mount that fine a blade.

Sander, jigsaw, and shaper—the Porta-Shop gives you all

The disk-sander table position is unusual, the work being well below disk centerline. But the author got used to this easily.

You can sand this way, too, even tilting table to sand beveled edges, but author found it difficult to keep disk from digging in.

A clamp holds down table saw while you work. Saw goes through 2" stock nicely on straight cuts but doesn't quite make it on 45-degree



miter. (Wood at right had been dressed to a net of 1¾".) Heavy stock is best cut to left of blade since table has most support there.

Cutting capacity, with the blade fully bottomed in the chuck, is not sufficient to cut through 2" stock with the smaller blades, but is more than ample with the longer, heavier blades. The smaller blades will breeze through ¾" lumber or plywood.

Other jobs. It's a 7" stationary or portable disk sander, although its merits in this portable area are questionable. I've never been keen on smoothing a surface with a portable, rigid disk. While you can use the fence as a guide for portable edge-sanding, it's hard to keep the disk from digging in.

The tool's least impressive setup is as a shaper, simply because 3,500 r.p.m. is much too slow. Feed must be extremely slow to come near a smooth cut. On this same setup you can use rotary files and small drum sanders.

The adapter for car-battery operation was not available for testing, but the Porta-Shop people say the unit will go five hours on a fully charged, heavy-duty battery. Adapters will be available for both 12- and 6-volt batteries.

Overall, the tool is what it sets out to be—a portable shop you can store on a shelf in the closet. All cased up it doesn't weigh more than 35 pounds or take up more than two square feet of space. Accessories include three spade-type wood bits, three high-speed steel twist drills, a 1" drum sander, a countersink, rotary file, shaper bit, three saber-saw blades, two circular saw blades—even a twist-type brush for cleaning the inside of the tubes. The cost has dropped from the original $300 to a list price of $259.50. ■■

these tools, too. Here's how you go about using them

Jigsaw setup seems more like an inverted saber saw but it was found to rival standard jigsaw except for fine fretwork and piercing.

Smooth routing and shaping are difficult because of the low speed. Vise plate is used as a baseplate so unit can be set vertically.

IF I COULD HAVE ONLY ONE CAMERA— I'd Take a Single-Lens Reflex

By Norman Rothschild

The author, a pioneer in single-lens-reflex photography brings you knowledge accumulated over 30 years as a professional photographer. His articles on photography have appeared in a variety of publications for more than 10 years

MY FIRST experience with a single-lens reflex was back in 1950. I was planning to buy a 35mm range-finder camera to shoot a wide variety of subjects in color. But I began having second thoughts when I added up all the gadgets I'd need—extra finders, optical close-up devices, adapters to adapt the adapters to other adapters. It wasn't just the cost. It was also the realization that the gadgets were simply makeshifts.

Then came a revelation. The store I was dealing with got in a shipment of Exaktas. One look into the view finder made a believer of me. I pointed the camera out the door and focused on a building across the street. The next moment I trained the Exakta on the storekeeper and was framing a portion of his face on the ground glass at a distance of only 18 inches. Never before had I held a camera that would allow me so easily to shoot a distant scene one moment and a close-up at the next instant. I was sold. Since that day I've done 90 percent of my picture-taking with single-lens reflexes.

No camera in the last decade has done as much to revolutionize picture-taking. It changed miniature-camera photography from a nightmare of fumbling with accessories to a dream of simplicity.

How does it work? The basic principle is beautifully simple

As can be seen from the diagram on the facing page, light from the lens is reflected from a mirror onto a ground glass. The image formed there—exactly framed—is the same as the one that will appear on the finished film, no matter what kind of lens

The ground glass shows you the composition and perspective you'll get in the finished picture. You can actually see just how much of the scene will be in focus (depth of field) at each diaphragm stop.

The finder in other cameras sees the subject from a point of view different from that of the lens that takes the picture (the difference is called "parallax"). It can only show you what the picture is *supposed* to look like. While most precision cameras have some kind of parallax compensation so you won't cut off heads when working close, this still doesn't eliminate the problem. The perspective you see in the finders of these cameras is *always* different from that on the film.

Buying your reflex. When you start shopping for a reflex you'll find a bewildering

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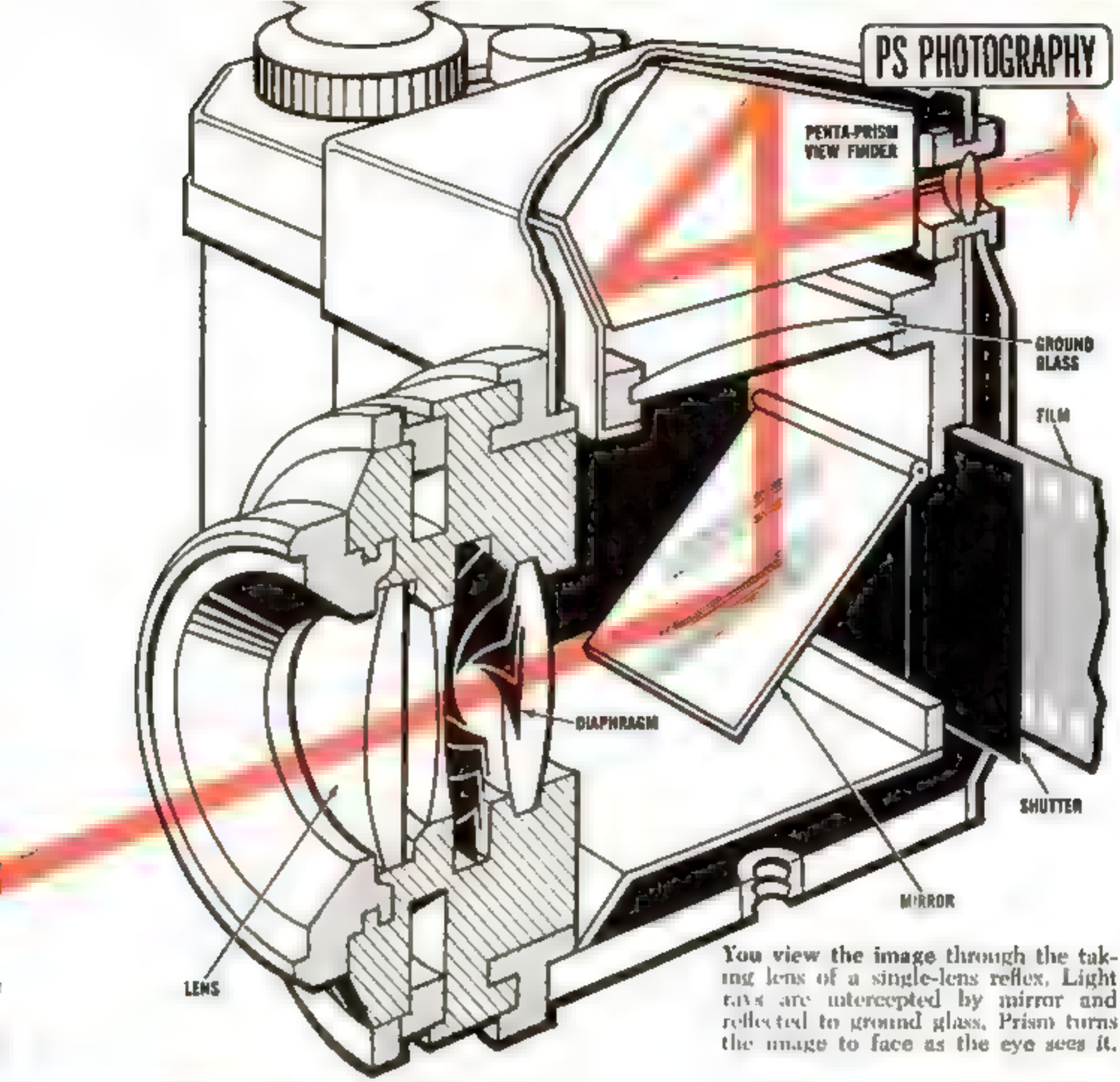
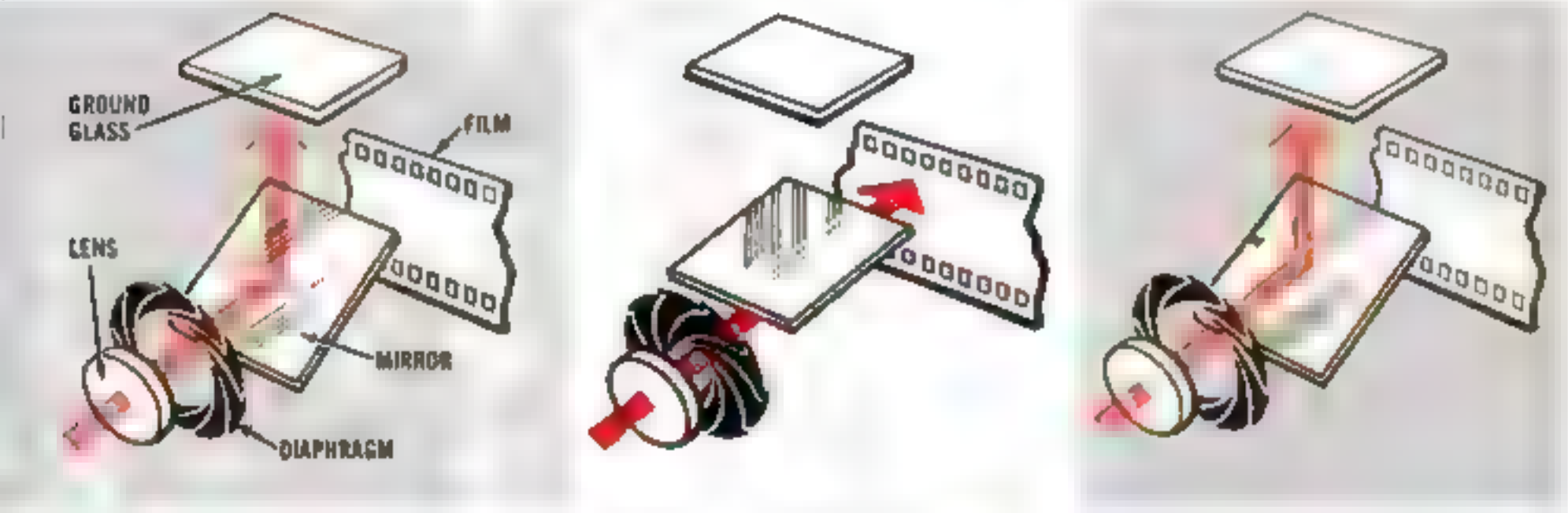


You view the image through the taking lens of a single-lens reflex. Light rays are intercepted by mirror and reflected to ground glass. Prism turns the image to face as the eye sees it.



How a modern single-lens reflex camera works

When viewing your picture-to-be, mirror is down, intercepting rays focused by lens and reflecting them onto ground glass. Diaphragm is wide open to give critically sharp focusing

Press the shutter release, and the diaphragm closes automatically to the desired stop and the mirror flips out of the way, permitting light to reach the film when the shutter opens.

After the exposure is made, mirror on modern reflex immediately returns to viewing position. On fully automatic cameras, diaphragm also opens, others require manual reset.

Facts About Single-Lens Reflex Cameras

array on your dealer's shelf. While the PS facts chart you see below will help you make a choice, you'll need to know some of the finer points of difference to keep from being disappointed with your final choice.

MODEL	BASIC LENS	RANGE OF LENSES	FINDER	SHUTTER SPEEDS	COMMENTS	PRICE
		35mm FOCAL-PLANE Reflexes				
Aspa 6C	50mm f/1.8	24mm to 600mm	Fixed prism, RF ground glass	1-1, 1,000	Field division of rangefinder is at angle of 45 degrees to vertical	$409
Beseler C Topcon	58mm f/1.8	35mm to 1,000mm	Prism or waist level, RF ground glass	1-1, 1,000	Optional factory-installed plain ground glass	$295
Canonflex RM	50mm f/1.8 50mm f/1.2	35mm to 1,000mm	Fixed prism, RF ground glass	1-1/1,000	Coupled exposure meter	$300 $425
Contarex	50mm f/2 58mm f/1.4	21mm to 250mm	Fixed prism	1-1/1,000	Coupled exposure meter, interchangeable magazine backs	$499 $589
Contarex Special	50mm f/2.8	21mm to 250mm	Prism or waist level	1-1/1,000	Takes RF or plain ground glass	$399
Exakta	50mm f/3.5, preset	24mm to 1,000mm	Fixed prism	1/2-1/250	Takes all Exakta lenses	$79.50
Exakta VXIIa	50mm f/1.9	24mm to 1,000mm	Prism or waist level; RF ground glass	12-1/1,000	Uses interchangeable plain and other ground glasses	$199.50
Honeywell Pentax H1 Pentax H3	55mm f/2.2 55mm f/1.8	35mm to 1,000mm	Fixed prism	1-1/500 1-1/1,000	Ground glass incorporates prism grid	$149.50 $199.50
Minolta SR-1 Minolta SR-2	55mm f/1.8 58mm f/1.4	35mm to 600mm	Fixed prism	1-1/500 1-1/1,000	Factory installed RF ground glass available	$179.50 $229.50
Miranda Automex	50mm f/1.9	28mm to 400mm	Prism or waist level, RF ground glass	1-1/1,000	Optional factory-installed plain ground glass, coupled exposure meter	$299.95
Miranda DR	50mm f/1.9	28mm to 400mm	Prism or waist level	1-1/500	Ground glass incorporates prism grid	$169.95
Nikkorex F	50mm f/2	28mm to 1,000mm	Fixed prism, RF ground glass	1-1/1,000	Metal focal-plane shutter, electronic flash synch to 1/125	$199.50
Nikon F	50mm f/2 58mm f/1.4	28mm to 1,000mm	Prism or waist level; RF ground glass	1-1/1,000	Uses interchangeable plain and other ground glasses	$329.50 $375
Yashica Pentamatic	55mm f/1.8	35mm to 400mm	Fixed prism	1-1/1,000	Other models available with RF ground glass	$159.95
		35mm LEAF-SHUTTER Reflexes				
Agfaflex IV Agfaflex V	50mm f/2.8, 55mm f/2	35mm to 135mm	Prism or waist level; RF ground glass	1-1/300	Accessory waist-level finder, $7.50; coupled exposure meter	$159 $198
Beseler Topconette	50mm f/1.9	35mm and 80mm attachment lenses	Fixed prism; RF ground glass	1-1/500	Depth-of-field preview; return mirror, coupled exposure meter	$140
Contaflex Super	50mm f/2.8	35mm to 115mm lens components	Fixed prism, RF ground glass	1-1/500	Coupled exposure meter; interchangeable magazine backs	$219
Fujicarex	50mm f/1.9	35mm and 80mm lens components	Fixed prism, RF ground glass	1-1/500	Depth-of-field preview, return mirror, coupled exposure meter	$150
Nikkorex 35	50mm f/2.5	35mm and 90mm attachment lenses	Fixed mirror; Porro prism	1-1/500	Coupled exposure meter	$119.50
Retina Reflex III	50mm f/2.8 50mm f/1.9	28mm to 200mm	Fixed prism; RF ground glass	1-1/500	Coupled exposure meter	$229.50 $263.50
Voigtlander Bessamatic	50mm f/2.8 50mm f/2	35mm to 135mm, and 36mm-82mm zoom lens	Fixed prism, RF ground glass	1-1/500	Coupled exposure meter; doughnut-shaped ground glass, rest is clear Fresnel, not for focusing	$209.50 $272.50

Nicely composed family shots such as this one are duck soup for single-lens reflex users.

Continuous view [illegible]

For extreme close-ups, [illegible] extension tubes, bellows [illegible]

Basically, single-lens reflexes may be divided into two general classes—those with focal-plane shutters and those with leaf, or Compur, shutters.

Focal-plane reflexes are more versatile than the leaf-shutter variety and are usually the choice of professionals. Since the shutter is close to the film, lenses of almost any focal length may be used. Commonly available lenses range from superwide 21-mm to ultralong 1,000mm. You can get an almost unlimited range of image magnification for close-ups by using extension tubes or bellows between camera and lens

In flash photography, however, the focal-plane reflex is restricted. You have to use special, long-peak flash bulbs These stay lit long enough for the shutter curtain to make its full traverse across the film. (A few late-model reflexes such as the Exakta VX11a, Nikon F, and others can use bulbs such as AG-1 and M5 at all speeds.) With electronic flash, only slow speeds such as 1/30 or 1/60 can be used. Exceptions are the Konica FS and the new Nikkorex F cameras, which employ a new type of bladed metal focal-plane shutter. This "synchs" electronic flash at 1/125.

Leaf-shutter reflexes are more compact, but their outstanding feature is the ability to use standard flash bulbs and electronic flash at all shutter speeds.

Because the shutter is either between the lens elements, or directly behind them, the number and types of interchangeable lenses for leaf-shutter reflexes are limited. While one camera, the Retina Reflex III, boasts a range from 28 to 200mm, a span of 35mm to 135mm is more common Nor is focal-length limitation the only problem. Most of the longer lenses for these cameras do not focus as close as do their focal-plane counterparts

For example: The average 90mm lens for focal-plane reflexes focuses to about 3½ feet. a 135mm to 5 feet. In leaf-shutter reflexes these distances average 6 feet and 12 feet respectively. This makes it difficult to take close-ups of heads. Even in the shorter focal lengths, the closest limit is about 3 feet.

For close-ups, leaf-shutter reflexes use attachment lenses. The working distances and magnifications with these are limited. And definition may not be too good when the extra-strong close-up lenses are used.

Most leaf-shutter reflexes don't allow you

[*Continued on page 162*]

Gus Teaches the Professor a Lesson

By Martin Bunn

"NOW that you have a helper, Stan," said Gus Wilson, "I'm going to the city to buy that new equipment for the Model Garage."

"Sure, Boss. There isn't much Ted and me can't handle for half a day."

"Keep an eye on him. He's a natural mechanic, but a bit cocky. That's the kind who sometimes goofs."

"Will do, Gus. No job goes out until I've checked it."

"Okay," said Gus, getting into the wrecker. "Use my car for road calls."

"Uh—just in case, Boss, would you tune in on the CB radio on your way back?"

"If you get into trouble," said Gus

The little professor brandished a big notebook. "I have it here calculated," he told Gus. "The volume of air is too small."

sternly, "handle it yourself!" As the wrecker rolled out, he added: "I'll turn the radio on at ten past the hour."

BETWEEN routine jobs and selling gas, the afternoon passed quickly. The gawky, red-headed teen-ager who had talked Gus into hiring him for the summer seemed to be in three places at once.

"Hold it!" roared Stan as the youngster, racing back from the pumps, made a leap over a big floor jack. "If the boss catches you doing that, he'll either bawl you out or fire you. Want to bust a leg sliding on an oil spot?"

"Nuts!" remarked Ted.

"Better watch it. Did you tighten the drain plug on that oil change?"

Ted's gamin face screwed itself into an expression of strained patience. "Think I'd forget a simple thing like that?"

"What're you going to do now?"

"Put this gas money in the till, drive the oil job off the rack, put new plugs in that Chevy and . . ."

"You'll burn yourself out before you can vote. And you'll burn out the engine in that Plymouth you drained," finished Stan scathingly, "because you never did put fresh oil back in."

Confidence oozed from the youngster. "Gosh—well, I was going to."

He bounded off. Stan noticed, approvingly, that he wiped the tops of the cans before puncturing them.

A yellow convertible rolled in at three. Stan did a double-take on its driver, a pretty girl with corn-silk hair.

"I need service in a hurry," she said apologetically. "This car skips and misses at times. A gas-station man said it needs new points, but he didn't have the right ones."

"We'll put them in, Miss."

"There's more. My father was leaving on an important trip, when *his* car died right in the driveway."

"I'll go there while my helper puts in those points. What's the address?"

She gave it, then stared at Stan until he felt a glow creep up his throat.

"Anything else, Miss?"

"I'd better tell you about my father. You probably never heard of him, but he's famous in his field—thermodynamics. That trip is to present a paper at the Polytechnic Institute . . ."

"Thermodyn—that's physics?"

"The science of quantitative relations between heat and energy," replied the girl, as if quoting. "He's a consultant for big engineering firms. He knows all about engines—on paper. He'll try to tell you what to do. But he doesn't really know about automobiles."

Stan grinned confidently. "Don't worry about that, Miss . . ."

"Tannenbaum. German for fir tree." She got out of the car. "Four o'clock?"

"Sure thing, Miss Tannenbaum."

CONTINUED

A loud if squeaky whistle issued from the back of the shop as the girl left.

"Fir tree?" piped Ted. "Willow would be more like it."

"That'll do," retorted Stan. "You put in and adjusted points yesterday. Can you do it again?"

"Easy as falling for that chick."

"I'll be back before you finish, anyway," was Stan's parting shot.

STANDING in the driveway of the two-car garage stood a four-year-old luxury V-8. Stan saw that the key had been left in it. He opened the hood, made sure that the coil lead was unbroken and both its terminals uncorroded and firmly seated, then turned to come face to face with the owner.

A round-faced little man in his fifties, he carried a notebook and pencil. Two clusters of white hair over his ears flanked an otherwise bald head and a huge iron-gray mustache

"My daughter sent you, yes? But with this engine it will be no use." He tapped a page covered with symbols and figures. "My calculations show there is not enough volume of working fluid."

"I was checking the wiring," returned Stan. "Will you try the starter?"

With a shrug, the little man got in. The engine chugged over—and caught. Working the throttle linkage, Stan gunned it to make sure it was taking fuel. "Must have been dirt in the gas line," he said.

Tannenbaum got out, shaking his head. His blue eyes looked right through Stan. ". . . an error in the isothermal compression figures? I must rework them . . ."

He trudged off, still muttering. Stan grinned, checked the automatic choke to make sure it had opened, and dropped the hood. The engine was still idling handsomely when he shut it off.

"I PUT the points in," said Ted. "Didn't want to leave the shop alone to test-drive the car, though."

"I'll take care of it later," said Stan.

But he was just finishing a job of his own when the phone rang. Stan listened, stammered a reply, and hung up.

"I've got to go out again," he muttered disgustedly

Taking along a set of points, a condenser, and a dwell meter, Stan returned to the Tannenbaum house. The big car stood a few feet from where he had left it. Leaning on a fender, his pencil flying, was the professor.

"As I told you," he said as if Stan had never left, "for adiabatic expansion is not enough working fluid—"

"Yes, sir. Your daughter says you tried to start on your trip again but the car quit after a few feet. I'll check the fuel system . . ."

"Fuel schmool! Fuel makes heat only. What must expand to push the piston? Air. Air iss the working fluid—only we haff not enough!" He poked at the sheet of figures. "Thermodynamics you cannot fight!"

"No, sir." Stan raised the hood, disconnected the fuel line at the carburetor, and triggered the starter solenoid. Gas promptly gushed forth

Reconnecting the line, he turned to the distributor and removed the points. They were badly pitted. He installed new ones and the new condenser, then set the points with the meter.

The engine came to life instantly.

"It's okay now," said Stan firmly.

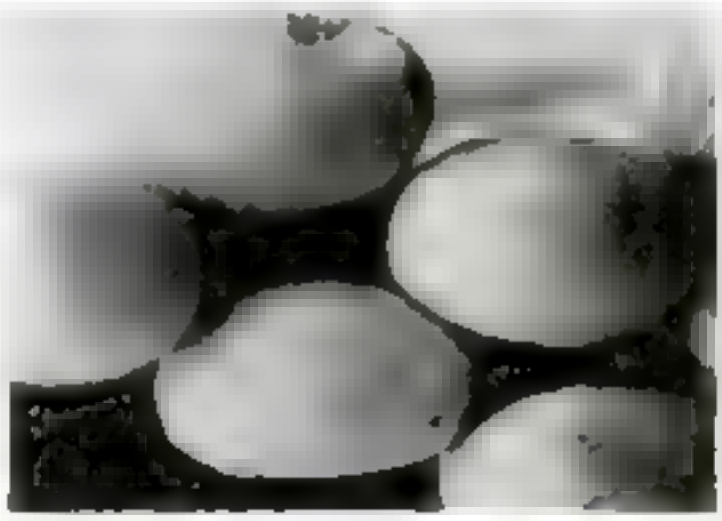
The professor regretfully closed his notebook. "So? Then it is time to go."

He went into the house. Stan gunned the engine, slammed the hood, and left.

AT TEN past four, Gus switched on the two-way radio in the wrecker.

"Some grief, Gus," began Stan. He told what he had done on Tannenbaum's car. "While I did that, the girl took her car out before I could check it. Now she's back, says it won't do over 20. And her dad's car quit dead for the third time. Could you go there?"

What's this a photo of?



ANSWER Not potatoes or dinosaur eggs—just the magnified beads of some book matches.

CONTINUED

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"Okay," said Gus, turning off the radio.

Sitting in his big car, a coat and briefcase beside him, was the professor. He got out as Gus came up.

"Perhaps you will understand." He brandished a big notebook. "I haff it here calculated. The volume of air is too small At isothermic compression . . ."

Gus nodded soothingly, flung up the hood and lifted off the air cleaner. Gas squirted into the carburetor throat on cranking. He opened the air cleaner, inspected the filter. It was clear. Leaving the air cleaner off, Gus turned the key. The engine started normally.

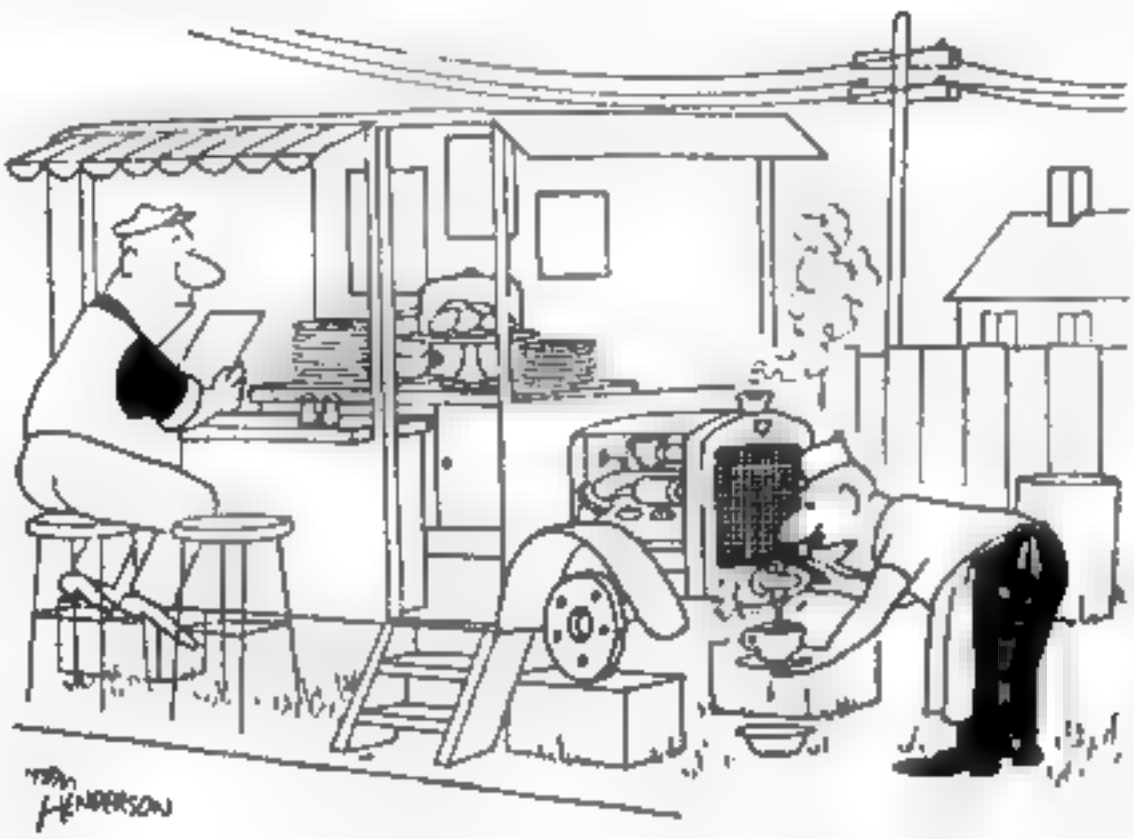
Tannenbaum shook his head. "I must at once recheck my figures . . ."

He disappeared into the house. Gus put the car into Drive, ran it up and down the driveway twice. Then he replaced the air cleaner and closed the hood. Again he put the car into Drive and stepped on the gas. The sedan moved—but the engine gasped to a stop.

When he opened the hood again, smell and sight told Gus the carburetor was flooded. A leaky float or jammed float needle? But they'd flood if the engine was revved with the car standing.

Thoughtfully Gus looked at the fiberglass hood insulation. In many cars a corner or two dangle loose. Here all were tight—but the middle of the blanket bellied out.

Carefully he pulled the sheet off and rolled it up. Closing the hood, he tested the car again. It ran fine.



"What'll ya have with your coffee?"

A HARASSED Stan met Gus when he drove in. Beside a yellow convertible a pretty girl gave the impression of stamping both feet while standing still

"Ted set the points right, Boss. But that engine breaks up at any speed over idling. The timing light shows the spark doesn't advance at all. But the vacuum line's okay, and the diaphragm couldn't go that bad all in one hour."

Gus walked over to Ted. "Have any trouble at all installing the points?"

"Naw. A breeze. I dropped a screw, but found a good one in the scrap bin."

"Show me which one."

Ted pointed to a screw in the distributor that held on and grounded the stationary points.

Gus took it out. "Thread's okay. How is it different from the one you lost?"

"Just a bit longer, maybe."

"Long enough," said Gus, "to bottom and lock the spark-advance plate. Get a new screw from the stock room, Ted."

Ted scurried off. As the girl was paying the bill, her father drove in.

"My daughter iss here?" he asked. "Ach, Helen, the Institute Meeting iss next month. I forgot it was postponed!"

The girl grinned wryly. To Gus, the professor continued, "My apologies. I found the error in my calculations. There was enough air, after all."

"No," said Gus, producing the hood liner "Not while this sagged over the air intake. It let enough air leak by for idling, but suction clapped it on tight when the throttle was opened, and it choked the engine. Want it put back?"

"Later maybe. We go now, Helen?"

"MEAN to say he really spotted that trouble—on paper?" asked Stan.

Gus grinned. "Well, somebody had to get under the hood, too. But I learned something—never ignore a clue."

"Me, too," put in Ted. "Don't use just any screw out of the scrap box."

"I like what I learned better," said Stan.

"What's that, Stan?" asked Gus.

"Her name," said Stan. "Helen." ■ ■

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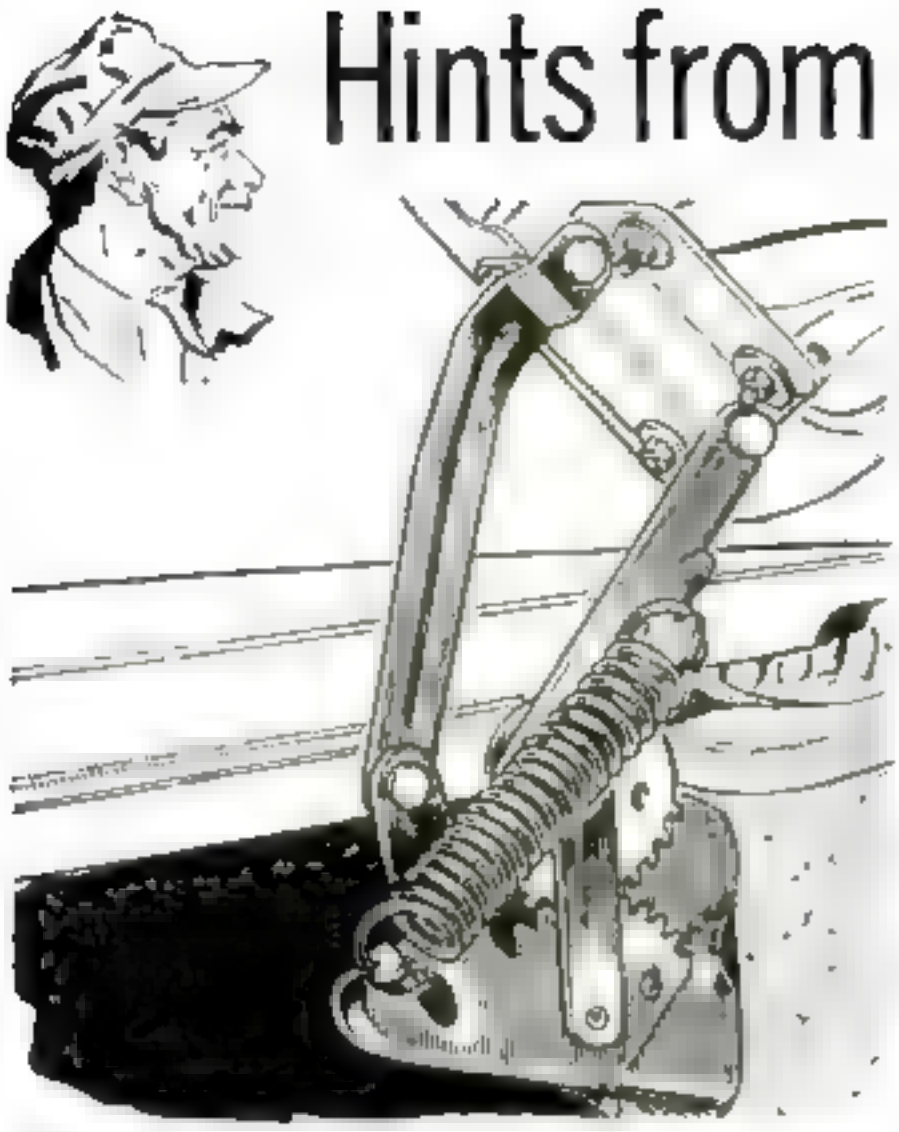
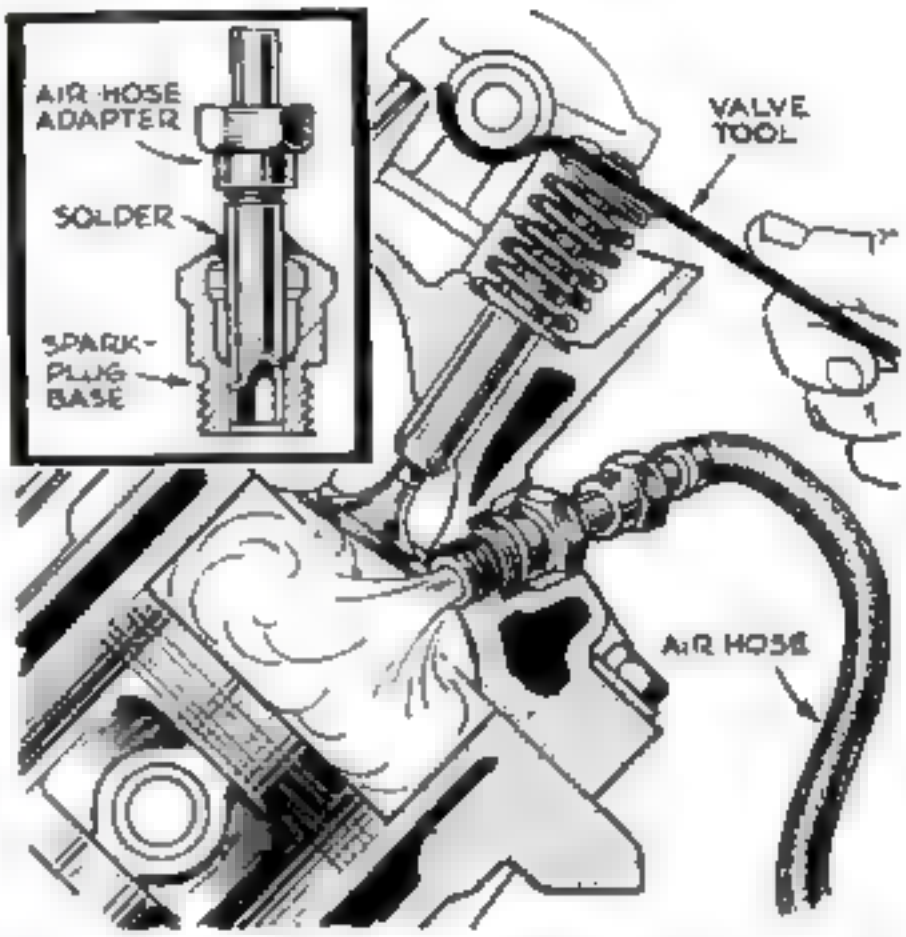
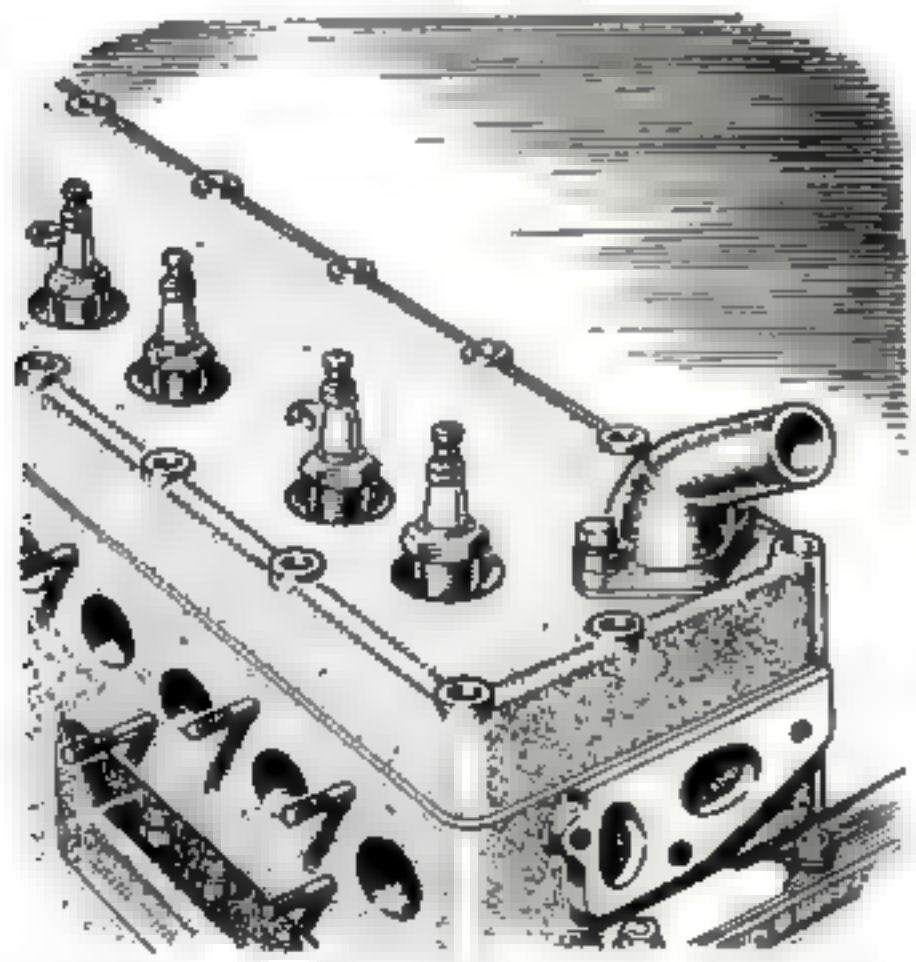
Hints from the Model Garage



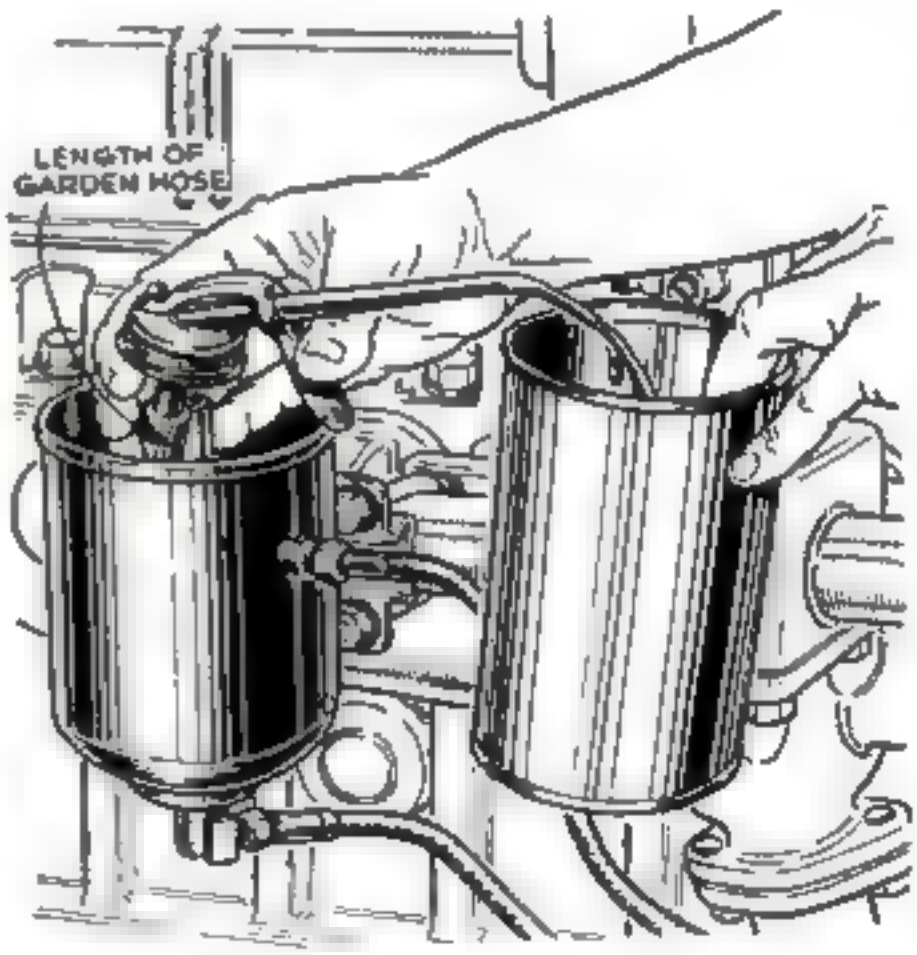
Check the position of hood springs before you unfasten them to remove the hood for major engine work. Reversing the direction of the spring hooks may prevent the hood from lining up properly with the cowl and fenders when you remount it.



To change OHV springs easily, one mechanic does this: He screws an air hose into the spark-plug hole, using an old spark-plug base as an adapter. The valve is kept from moving into the cylinder by 80-100 p.s.i. Unplug the oil pan, set piston at TDC.



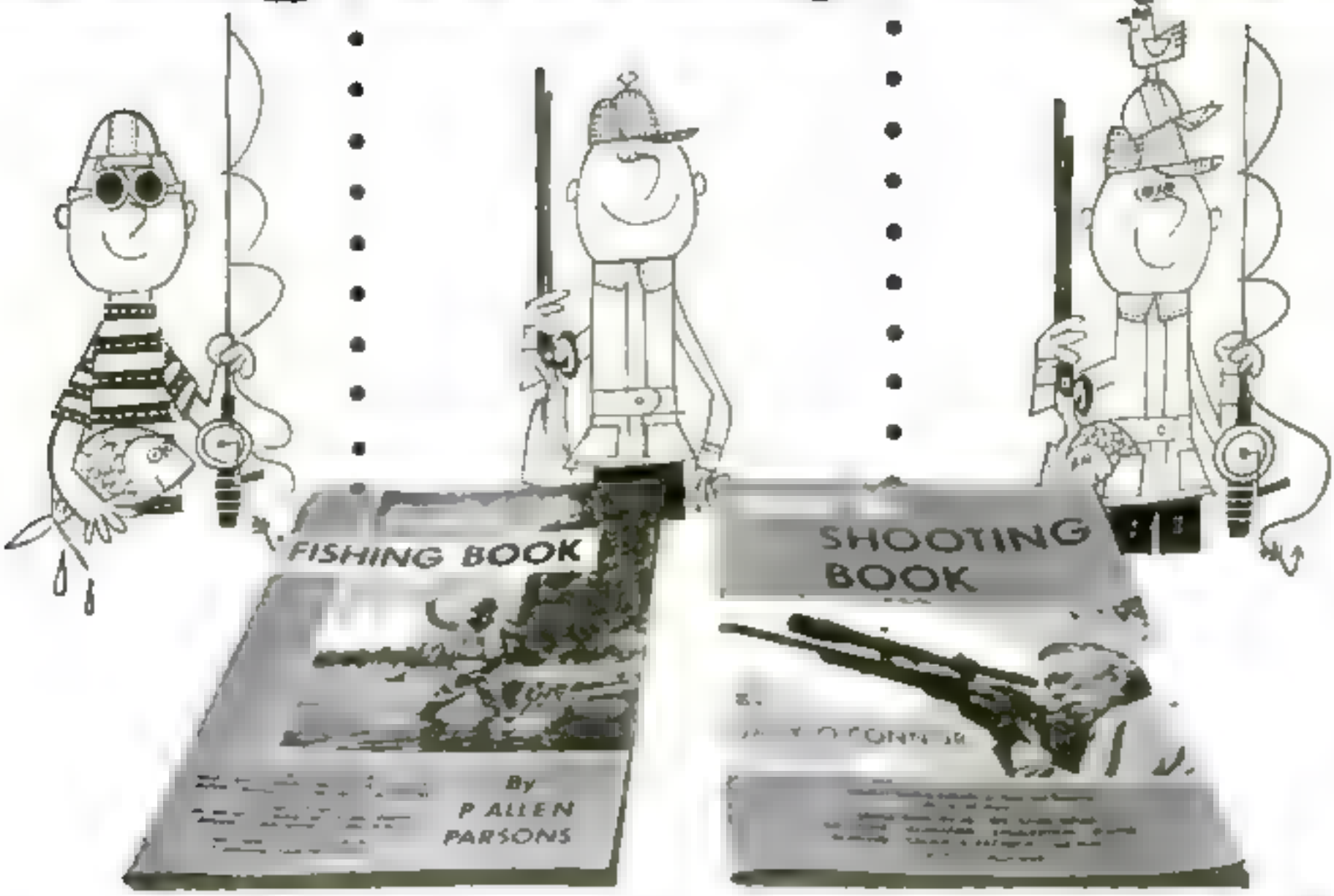
To free a cylinder head that's "frozen" to the block, try this easy trick: After you have removed all retaining nuts and bolts, engage the starter. This will build up sufficient compression to loosen and lift the head and save you a struggle.



Changing an oil-filter cartridge gets messy when it's time to drain dirty oil from the filter case. A neat way: Pump out the oil with a plunger from an oil squirt can connected to a piece of old garden hose. Tape the plunger shaft for a good seal.

CONTINUED

fishing? shooting? or both...



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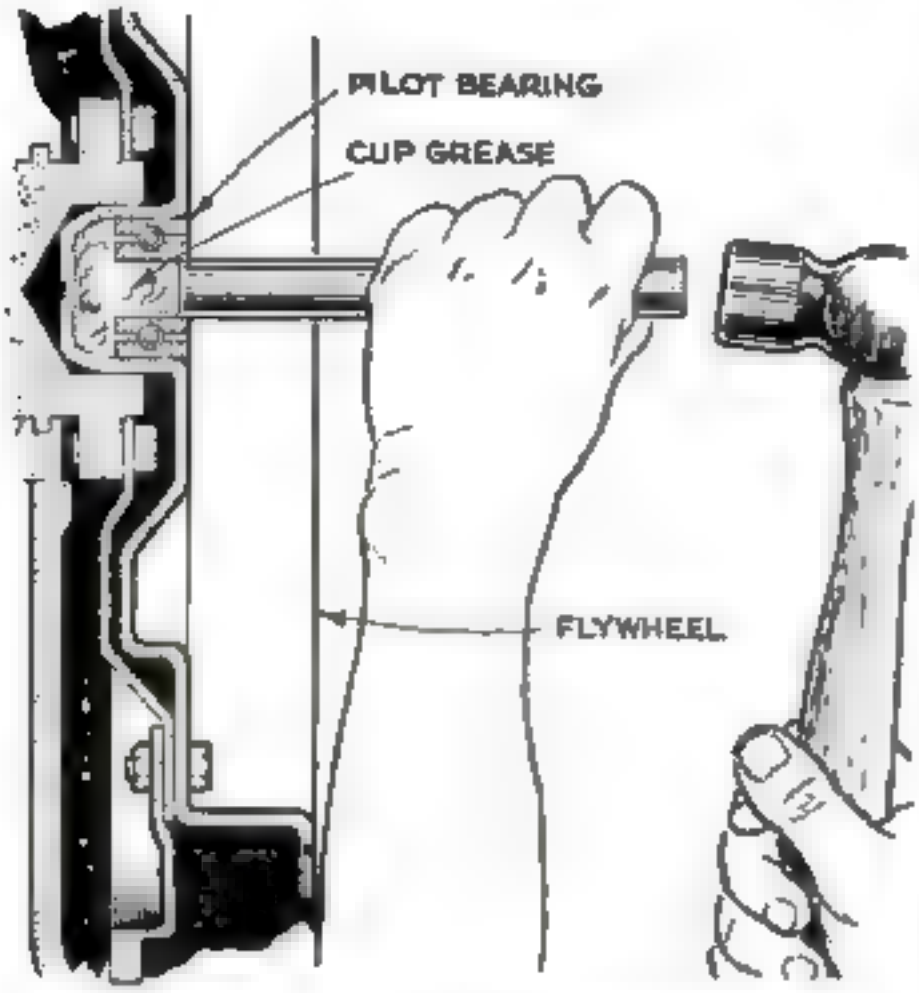
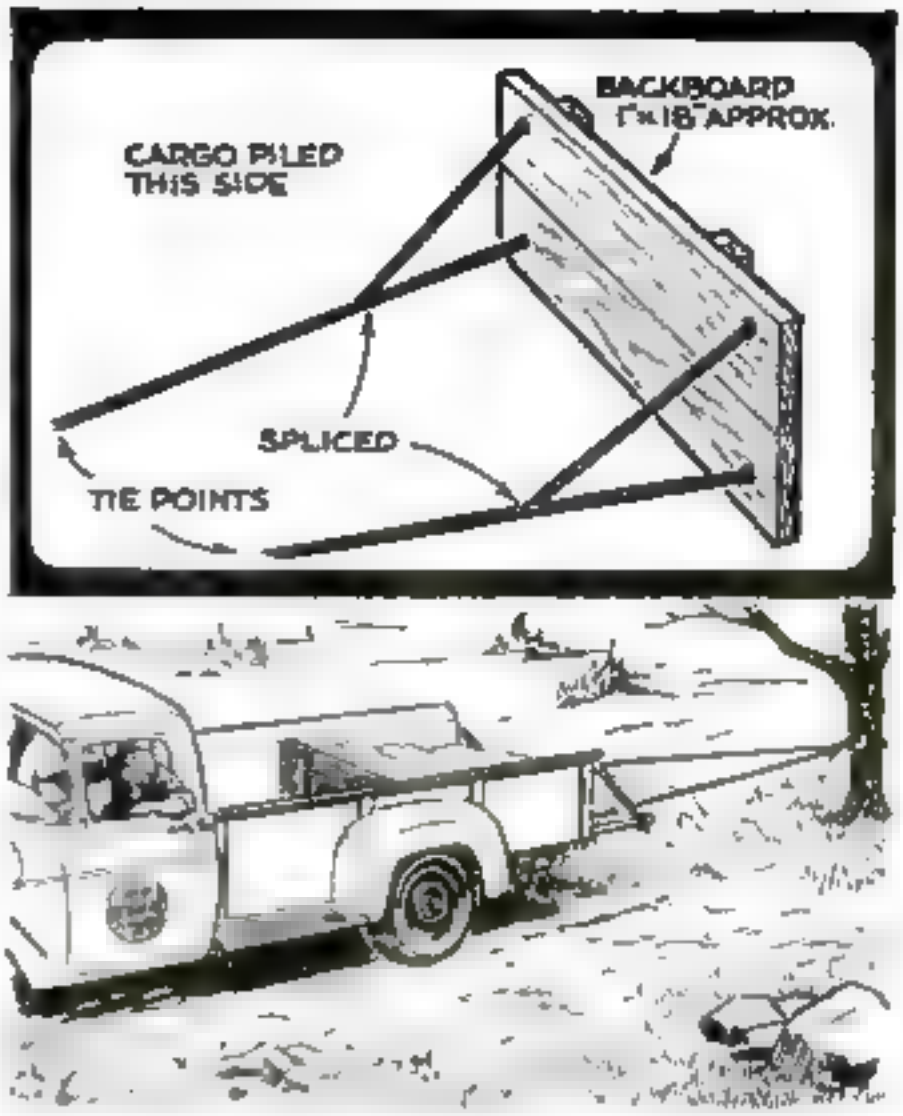
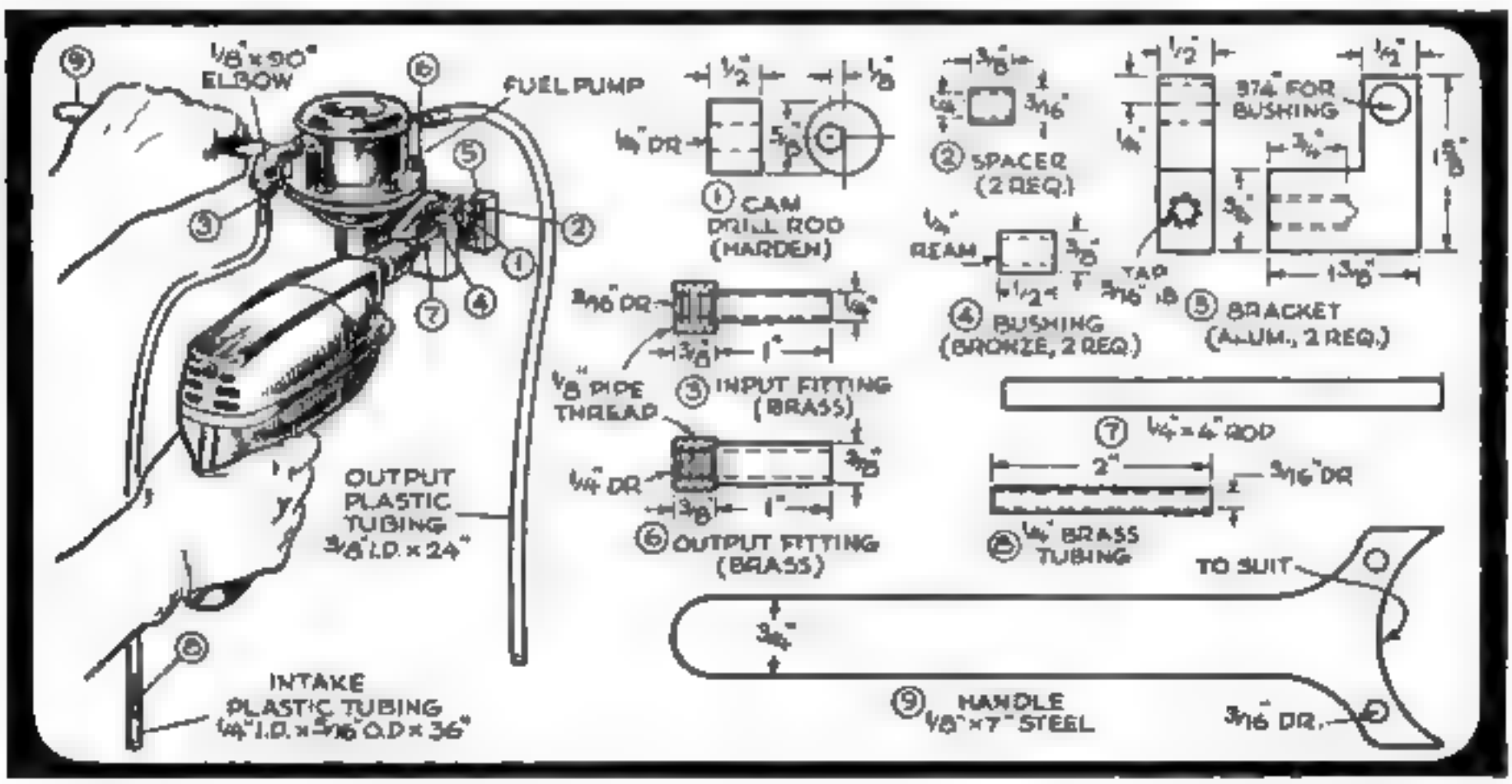


Always replace the pilot bearing when you do a clutch job. To remove the bearing, fill its hole with cup grease. Insert a rod of the same diameter as the main shaft into the hole and tap it in with a hammer. Hydraulic pressure forces out the bearing.



Unloading a pickup truck is easy with this dump bridle. Cut a wooden backboard the width of the pickup bed and place it behind the cab. Then tie a bridle as shown. To dump, secure bridle to a tree or other anchor. Drive forward to empty bed



Drain crankcase oil from the top? One mechanic with a flair for machine work does it with the outfit above. An electric drill drives a converted fuel pump, the input tubing being thrust down the oil-filler or dipstick hole. Quarter-inch brass tubing inserted into the end of the intake line acts as a weight to hold the line down. The ⅛" steel handle is convenient for steadying the pump. Adapt the drill with rod, bushings, cam drill rod, spacers, and brackets as shown in the diagram above.

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[Continued from page 131]

to preview depth of field. Exceptions are the Beseler Topconette and the Fujicarex cameras, both of which have depth-of-field preview levers.

Finally, the instant-return mirror, described later in this article, so far is available only on one or two leaf-shutter reflexes.

View finders. Most picture-taking with a modern single-lens reflex will be done while you're sighting through a penta-prism eye-level view finder. In this the image appears right side up and faced as the eye sees it. In some cameras the eye-level penta-prism can be interchanged for a waist-level finder.

The ground glass you see in the finder is vitally important. Some old-time diehards like myself prefer a straight ground glass. We like to see the image, and be able to judge all parts of it unobstructed by focusing aids. But I'll admit that in poor light it is difficult to focus with an unaided ground glass. Thus many manufacturers offer, or incorporate on the ground glass, a prism range finder. This occupies a small section in the center. The image in it appears broken, or discontinuous, when the subject is out of focus. For critical focus, you simply adjust the lens until the halves of the image are in line.

A variation of the range-finder principle is used in the Honeywell Pentax, Yashica Pentamatic J and S, and Miranda DR. In these, a portion of the focusing area is embossed with a myriad of tiny prismatic elements. When the image is out of focus, a distinctive gridlike pattern is seen. This disappears as the image snaps into focus.

In the Exakta and Nikon F, the user can interchange ground glasses. In other cameras, the factory will install the kind of ground glass you like.

The Contaflex, Contarex, Aires Penta, and the new Yashica Pentamatic J and S have unique finders. In these the center incorporates a range finder, around which is a doughnut-shaped ground-glass area. The rest of the finder is usually clear. It cannot be used for focusing but gives a very bright view. The range-finder area is best for focusing objects having straight lines, the ground glass for focusing confusing subject matter such as foliage.

Lenses. In the early days of single-lens reflexes, lenses with manual diaphragms were supplied. To use these you first focused with the lens wide open. Next, you moved the camera from your eye and closed the lens down. Then you put the camera back to your eye to shoot the picture—if you could still frame properly with the resultant dark ground glass.

The preset diaphragm came next. In this a ring is set to the desired aperture. After focusing with the lens wide open, you push the diaphragm lever till it stops, whereupon the lens will be at the desired preset aperture. The preset diaphragm is no longer generally supplied on normal lenses, but is sometimes available on telephoto and wide-angle lenses.

The next great advance was the automatic diaphragm. This closes automatically to the desired aperture when the shutter-release button is pressed. Several different schemes are used:

Early lenses had their auto mechanism built on externally. Many of the lenses supplied for the Exakta and Alpa cameras still use this construction. While it is considered bulky and old-fashioned by many, I prefer this system over the kind built into the camera body. Gentle pressure on the release button first closes the diaphragm, letting you see the depth of field; further pressure then releases the shutter to snap the picture.

When the automatic stop-down is built into the camera body, you can't be sure that the lens *is* stopping down. Malfunction may go undetected until you see the processed film.

Return mirrors. In early single-lens reflexes, as well as some models still available today, the image blacks out completely as the mirror tilts out of the way, making it impossible to follow action or see changes of expression. The "return mirror" flips back to the picture-taking position immediately after exposure.

The latest refinement to be added to the single-lens-reflex list is the built-in exposure meter. At first this was simply a small meter built into the camera body. Later, the meter was coupled to either the diaphragm or the shutter, or both. Thus, taking an exposure reading also sets the camera for correct exposure. In some cameras a meter is not built in, but a clip-on type, which couples to diaphragm or shutter, is available as an accessory. ■■

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[Continued from page 39]

police-pursuit business needed to be changed from a haphazard, deadly game into a science.

His chiefs, Col. David Lambert and Commissioner Edward Scheidt, a former FBI man, okayed the first scientific study of car chasing. North Carolina has 70,000 miles of highway and Jones began working on many of them. Today you may see him, stop watch and notebook in hand, timing actual chases. He wants to know *everything*: how long it takes to gain 10 m.p.h., how many times a trooper twists his head when he gets out of a car, how long it takes the average driver to stop when he's signaled. Photographer Bill Morris and I rode with him one day recently when he began timing how soon a motorist doing 55 m.p.h. hears a trooper's siren. The results were startling. Repeatedly, we had a car with screaming siren chase past us at high speed—and we never had more than a *one-second* warning.

Jones, a thorough technician at heart, has a mind for details. He's learned:

Turns. The frantic, unscientific turnaround you see some untrained police make can use up 30 seconds—in which a fugitive can be 4,000 feet away. But a North Carolina "precision turn" takes only 10 to 13 seconds. And a perfectly executed U-turn, without tire screams, can be done in only six seconds.

When this happens, a dangerous five-mile, four-minute chase is often cut to a minute or less.

Jones has found that ordinary drivers may take 56-58 feet of road width for a 180-degree turn. Carolina troopers can do it in 42 feet. The Carolinians have a trick that may help you to turn better. Instead of powering into a fast U-turn, they come to a full stop—straight ahead. Then they grab two fistfuls of steering wheel and cut their front wheels all the way over. Only now do they move into the turn. Here a civilian or rookie is tempted to pour on coal. Troopers don't. They feed gas very slowly. "Anything else," says Jones, "runs you off the other side of the road—or you may have to stop and back up."

Starts. Jones has found that if two troopers start side by side, the fellow who gets the quickest start is the one who *doesn't* burn holes in the road or spit sand. And a three-second delay here can mean losing a car. He's also noted this: Starting from stop signs and traffic lights, civilians tend to dally—prolonging their "exposure." Troopers "start safely but energetically."

Fast pursuit. New troopers fresh from civilian driving tend to ride too close to the car ahead (a danger that the driver on our cover is demonstrating). Drunks and criminals may take advantage of this by slamming on their brakes and trying to wreck the trooper.

Arresting. Beginners tend to pull up alongside, or ahead, of the car being stopped. But a motorist who gets stopped may hit his brakes in panic, causing the trooper to end up ahead of him—which is dangerous.

Hence troopers are trained to pull up along the left rear fender of the car being stopped—no farther. Here an amateur would have his siren shrieking wildly. But Jones' men (and good troopers all over) merely touch the siren button quickly (usually with the left foot). And more and more, they now merely tap their horns and point over.

Braking. A police car can wipe off 10 miles per hour per second by hard braking. In other words, it takes three seconds to knock speed down from 70 to 40. Troopers rarely hold brakes on more than three seconds at a time—to avoid burning their brake linings.

At 110 m.p.h. Jones would scarcely touch his brake but would let his engine slow him down to 90, which is about the top safe braking speed. Hard braking at high speed could lock front wheels and kill turning ability.

Drop-offs. One danger that plagues beginners (and many civilians in ordinary driving on narrow roads) is dropping a wheel off the left edge when

overtaking a car. Most drivers think this tends to pull a car into the ditch. It does—if a front wheel drops off. But if a rear wheel drops over the edge a driver tends to overcorrect in panic—and plows into the side of the car he's passing.

When Jones finds a problem, he digs for causes. One cause of drop-offs, he found, is inexperience. Another is watching the car being passed. A third cause, however, is this: Any driver who suddenly swerves out to pass tends to kick his gas hard. This throws his car ahead. But it also hurls it sideways—and the *lateral* thrust takes him over the edge.

Hence Jones cautions troopers: Pull out early and get established safely in the passing lane before you come up.

Rollovers. In civilian crashes, Jones noted, few drivers survive high-speed collision with fixed objects: big trees, rocks, parked trucks. And so he teaches: "It's better to roll your car. Lots of drivers live through rollovers—especially if they wear seat belts."

But where's the safest place to roll? Most beginners answer: an open field. No, says Jones: thick underbrush.

Skidding. Troopers avoid it like death "Once you skid," says Jones, "it takes power and luck to get out of it. And getting out may roll you, run you off the road, or hurl you into another car."

Parking. Says Jones: "We can tell the minute we see you park whether you have—or can learn—the feel for a car that a trooper needs. Most civilians need at least one minute to park in a tight spot. Some actually need five. The best ones park in maybe 30 seconds.

But Carolina troopers learn to use a 20-second parking formula. Like this:

1. Line up rear bumpers.

2. In first six feet of backing, grab wheel and give it *two full turns*. Now stop and see how you're doing—since there are always slight variations. You should be at a 45-degree angle.

3. Now back slowly, while making *four full turns* the other way.

4. On approaching the car behind, you may see that a further turn is nec-

CONTINUED

essary—depending on the length of the parking slot. If so, make a *second full stop* (with power steering), or a "creeping stop" (with no power steering), and here make the final steering adjustment.

Result: a crisp, clean 20-second park.

The test course. Jones' skill-test courses are laid out on a football-size field at the University of North Carolina. Here you have to be able to squeeze a chase car through incredibly tight lanes—long before you're trusted with patrol work. There are tests for backing and turning—and one devilish thing that tests your ability to weave.

I took this test (I'm sorry to report). Here, compressed into 450 feet, is a five-mile chase past 96 cars and trucks, each represented by a rubber cone. The cones are bunched treacherously—as cars bunch together on the road.

I got down through it all right by holding my breath—there was only six inches of tire clearance on each side. "Now back up through it," said Jones with a wicked smile. "Some of our boys do it clean as a whistle in 15 seconds.

"And," he added, "you can't use your mirror. No one should ever back with a mirror. Look backward—and here's a tip: Keep your eyes turned backward."

So I backed through the course. Like you, I thought I was reasonably handy at the wheel. Halfway through I nuled two cones, which could have been a Ford truck and a Greyhound bus. I backed 400 feet in 26 seconds, and then —chaos. In the last two seconds I mowed down a Cadillac, a Fiat, a couple of Fruehauf trailers, and three Ramblers. Cones were rolling everywhere.

And there was Jones.

"What happened?" I asked. "Where did I go wrong?"

"You made the civilian's usual mistake," he said. "A civilian may back well at first. But then, in the last few feet, he can't resist the inclination to look forward to see where he's been."

He wrote down nine demerits. "Tsk, tsk," he said sadly, "my boys will just have to teach you how to drive." ■ ■

[Continued from page 56]

other 650 gallons of clay is pumped aboard. The prop never stops and I barely have time for a cold drink. In just over a half-hour my turkey and I are gliding in to the second attack. This time we start from a little farther up the slope and come down to angle the clay along the rear of the first strip, taking up where that left off. The blaze had swept partly around the mud, but not over it. Had there been another plane on that first attack, we could have closed the entire canyon, which shows why two planes are considered four times as effective as one against a fast-running fire.

Approaching now, I see more of the first drop's effects. The bentonite had leveled brush, stripped burning limbs from the firs, and knocked over the weaker trees. On this second pass all the ground troops are safely tucked behind boulders.

Again there's the whooshing thump of the pink mud, the leap of the turkey and another link of armor has been forged against our enemy. The gap across the canyon is closing fast now. We had been called at 1600 that afternoon. By dark, five loads have been placed, the last one a smothering mop-up affair from slightly higher than the usual 75 feet. The ledge atop the rock face has been thoroughly plastered. And the fire, which hours before had been racing uncontrolled toward a waiting forest, is now a forlorn mess. The ground troops, rushing in with shovels, scoop the clay onto live embers, beat down the occasional spurt of windblown outbreaks, and we have won.

No wonder the Forest Service considers this airborne mud their best, if not their only, weapon against fires isolated by terrain or distance. This summer, with more campers heading for the woods than ever before, they plan to use it more frequently as a first measure. A blaze will be hit within minutes after sighting, rather than hours or days.

And we'll be ready, my turkey and me. ■ ■

[Continued from page 44]

which drive it high and away from the decks. Should the wind be in line with the ship, the bonnets center, and equal amounts of smoke pour from the vents on both sides."

940,000 revolutions per crossing. Chief Engineer Bouey set up an orderly program for my four days aboard. Next morning I was in the forward boiler room—a steam-fitter's paradise that rose five decks from the ship's double bottom.

It would have been hard to imagine a more awesome complex of boilerplate, piping, valves, pumps, and gauges. But my guide, Engine Officer Yves Tabouret, told me I had only to walk through a few compartments to find an identical setup. "One can tell them apart only by the men at the controls. Our engine rooms are also twins."

I asked: "Suppose this plant or the other was knocked out by a fire. With the hull undamaged, how fast could the remaining engines drive the France?"

"At 23 knots. What makes it possible is the large reserve power. You will note from this dial that our speed is now 32 knots. You will also note that only three of the four boilers are being fired. The same is true in the other boiler room."

I hadn't noticed. So I squinted into each firebox. Mirrors gave me profile views of bundles of burners spouting blue flames in units 1, 2, and 4.

"While you are peeking," Tabouret said, "look through this periscope above your head."

It took me a moment to identify the image. It was the nostril of the smoke deflector on the stack 150 feet above us. "The exhaust is clear," I reported.

Tabouret laughed. "If it was not, we would hear very soon from the bridge."

On an instrument panel, I checked the boiler pressure (925 pounds to the square inch), and the temperature of the superheated steam (1,042 degrees). There were other vital readings, too; but what stirred my curiosity most was a small tachometer flipping digits at a modest pace.

CONTINUED

"That," said Tabouret, "is counting the turns of the propeller shafts. Before the start of each transatlantic crossing, we set it back at zero. Remarkably, at the end of the trip, the reading is always within a few thousand revolutions of 940,000."

Why not an electric drive? The forward engine room was quiet, cool, and unspectacular. Under burnished housings, a four-stage turbine setup was fanning out 2,878 smooth revolutions a minute. In a gearbox beyond, this was dropped to 156 r.p.m.s—the speed of the two outside propeller shafts.

There were two other turbines for reversing. "On one test," Tabouret told me, "we cut them in from full-speed ahead and stopped the France in seven of her own lengths."

I mentioned that the Normandie had eliminated reverse turbines with an electric drive. "Why did you give it up?"

"Most importantly, because today's superior gears cancel out the former great advantage of electricity—smoother operation. So we can now make use of the higher efficiency of gears. Too, the cost is less. Finally, it would take almost impossibly large electric motors for the 18-to-1 reduction used with the France's modern, low-speed shafting. Large propellers with a steep pitch make up for the slower revolutions and are more efficient."

A final question: "I understand the France carries enough fuel oil for a round trip—9,000 tons. That comes to 270 railroad tank-car loads. Where do you find room for it?"

"We could not, if we still had to store great amounts of fresh water, as in the case of the Normandie. She took on board 4,600 tons each time she entered port. The France does not. She simply distills salt water as she needs it—at a rate of 1,400 tons a day. Thus we let the ocean carry the reserve while we carry more oil."

Blue doors are not for decoration. To her 400 First Class and 1 600 Tourist Class passengers, the France is an eye-popping palace in which color plays a key role. If a book in the ship's library is bound in blue, it's in French; red is for English, yellow for German, Spanish, or Italian.

I soon found a more significant example of color coding. Scattered along several miles of corridors are occasional blue doors. These are service entrances. Behind one, chattering relays put through as many as 50 telephone calls simultaneously among the ship's 1,300 phones.

Then there are the blue doors leading to 102 air-conditioning centers. Again the France tops the competition, with a capacity of 2,200 tons of refrigeration. For a comparable cooling job, you would have to melt a column of ice one foot square and 15 miles high each day.

Still another door conceals a miniature telecasting station. There are seven cameras spotted about the France to help its personnel whip up shipboard programs. And French, British, and American telecasts, when within range, are picked up and relayed to public rooms and some of the First Class cabins.

In the audio line, pickups from the ship's ballroom and music salons—along with tape and disk recordings—are piped to all First Class cabins. If you want the long-hair stuff you punch a button with a violin etched on its face. For jive you press the one with a picture of a saxophone.

Finally, there's the blue door for the Central Security Control room. Its officers constantly scan a big panel that would show the location of a fire on any deck. Lights would flash on, and signals would blare. On a second board are the switches that send fire doors gliding to closed position. A third panel controls a carbonic-gas network.

13½ million watts. To meet the electrical needs of the France, enough wire to reach nearly around the world distributes a peak load of 13,500 kilowatts. Six turbo-alternators—three in each engine compartment—spit it out at 440 volts. The regulators are normally set for 60 cycles. But when the France

berths at Le Havre, she conforms with French practice by cutting back to 50.

I spent a day with Chief Electrician Roger Quénot inspecting this power plant—or, more correctly, two power plants, because the France is split, electrically, right down the keel line. One bank of generators feeds the port side, the other the starboard. Should one system conk out, juice from the remaining setup can be shunted anywhere.

"How about a double failure?"

"Then a pair of diesel-alternators assumes the task. If they fail, we still have batteries."

Managing the current. Two distributing stations hold the reins on all the current. In the larger one, Dispatcher Theodule Troszezynski traced the major arteries for me on his color-coded console. Part of the 440-volt supply is poured directly into the motors driving the big pumps in the boiler rooms and the major winches. The rest is stepped down to either 220 volts for smaller motors and the all-electric galleys, or to 110 for lighting and cabin outlets.

"There is little variation in the hour-to-hour demands," Troszezynski said. "But when the kitchens are preparing 2,000 meals—" he shrugged and swung an arm expansively above the intermediate-voltage meters.

On the last day out, I was downing my *dejeuner* in the posh First Class dining room when an announcement came from a hidden squawk box. It was in French, but I caught the words "*Etats Unis.*" Most of the diners went on chewing. But with a few others, I galloped up the Grand Stairway and onto the sun deck.

The nearly 10-year-old S.S. United States was streaking by, Europe-bound.

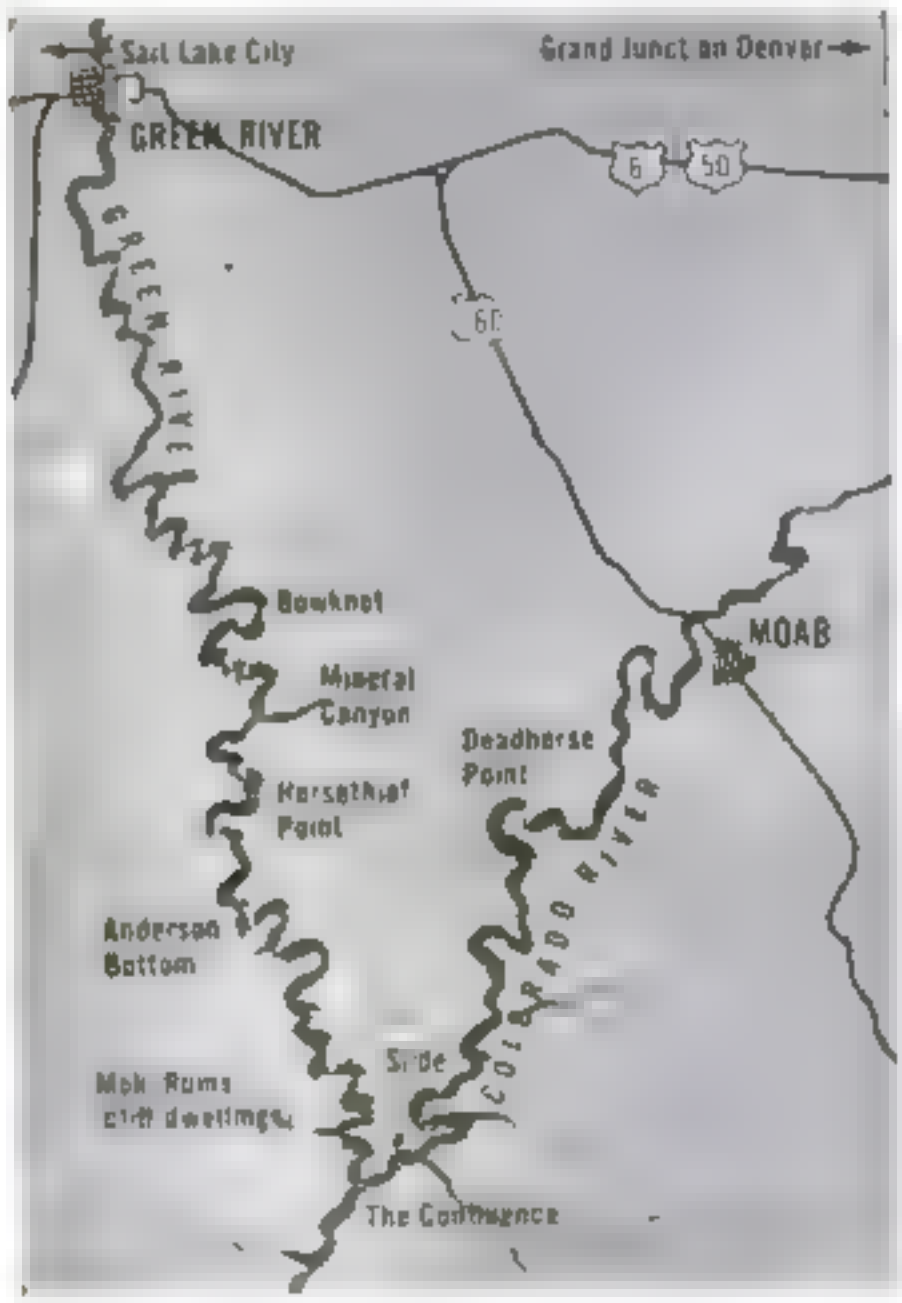
Many sentimental words have been said of great ships passing in the night—or any time. But as she and the France fell away at an opposed speed of nearly 75 miles an hour I caught myself saying to no one in particular: "Obsolete? Golden galleons sailing into the sunset? My foot!" ■ ■

No Prop, No Rudder—No Sweat

[Continued from page 82]

to be towed out—mostly with outboard lower units shattered. Innumerable shear pins were replaced en route and few, if any, boats came through without hanging up on sand bars.

Check-out ride. My first encounter with a jet-drive boat came the afternoon before we started downriver. Bob Barnes, an engineer from Berkeley Pump, took Arnold Feller and me for a spin to check us out on the boat. The river was brim full, the chocolate-brown



water racing recklessly downstream as though it felt out of place in the desert surroundings.

I took over the helm in midstream and gingerly tried the controls while we continued upriver about half a mile. It was startlingly quiet and free of vibration. I opened the throttle. We took off like a scalded cat. The boat responded smartly to the helm though I found the wheel harder to turn than I had expected. At high speed I was overcontrolling. I released the wheel momentarily and the boat continued on

course, as straight as a flying arrow.

The river narrowed and I decided it was time to go back. I edged toward the right bank to leave plenty of room for a U-turn. I cut the throttle to come around cautiously on my first sharp turn, and spun the wheel over. Nothing happened. I learned my first lesson about handling a jet: Without power you have no directional control.

There is nothing resembling a rudder to steer you when you're coasting. But I soon found that if you coordinate wheel and throttle, you have better control in a sharp maneuver than with a conventional boat. You cut the throttle, put the wheel hard over, and then control the sharpness of turn by the amount of throttle. You can do an abrupt about-face in little more than a boat length this way. But it takes care. Until you get the feel, it's easy to spin out.

Our test boat. The PS boat had a 19-foot fiber-glass hull built by Lone Star, powered by a V-8 Crusader engine direct-coupled to a 12-inch Berkeley Jet Drive pump. Nominal factory rating of the engine is 200 hp., but Bob Barnes, the Berkeley engineer, told me it was actually developing some 160 hp. maximum at our altitude. The pump, he said, would jet out about a gallon of water for each r.p.m., or roughly 3,500 gallons per minute at cruising speed.

If there were any weaknesses or drawbacks to a jet boat, we intended to find them in the next three days. There are few waterways in the country where a jet is needed more or where there is more reason for traveling by boat.

The rivers are the only roads through most of the canyon country of eastern Utah. And even these can, to put it mildly, be rather unsatisfactory highways. For most of their length, the Green and Colorado are fiercely inhospitable. The grandeur of the richly colored canyon walls and nature's massive, recklessly carved sculptures are jealously guarded by rapids too hazardous to navigate. But when the rivers are full, the stretches between Green River and

CONTINUED

No Prop, No Rudder—No Sweat

Moab are relatively peaceful—navigable by any reasonably competent boatman in just about any kind of a family boat except an inboard (unless it's a jet). Still, you wouldn't want to make the trip alone—there's only one road out in a 130-mile stretch and you might wait weeks for a passing boat.

We're off. Our first afternoon's running took us to a campsite at Anvil Bottom on the west bank of the Green about 20 miles below Green River. Arnold Feller and I took turns at the wheel—getting the feel of the boat before we got into the rougher going ahead. Cruising at around 35 m.p.h. on flat water, the boat was docile and obedient. We passed a dozen or so outboards in the first few miles.

This brought up the only handling problem I encountered. Coming into the wake of a fast-moving boat and cutting out to go around, the craft acted much like a hard-mouthed nag with a perverse disposition. It tended to lead us down the trough of the wave, and it wallowed alarmingly when I finally forced it to cross. Was this a characteristic of the jet drive, or simply of the installation in this particular hull? I made a note to try the other jet boat, which, brought along by the Berkeley Pump people, was following us.

We stopped several times for sightseeing trips and to explore the Moki Indian ruins along the river banks. My first few landings were anything but graceful. I couldn't get used to not having a rudder for the power-off over-run into the landing.

The second day we were deep into the canyon country. We soon saw plenty of reasons for being glad we were in a jet. We passed a number of boats with their passengers slogging around in the water trying to get them off sand bars. Some were tied up at the bank getting new shear pins or props. Almost all of the boats underway had a crewman taking soundings continuously with pole or paddle. We glided nonchalantly by, weaving in and out and taking

short cuts across water that would be hazardous for prop-driven boats.

Only once did we run aground. Fortunately we were going slow at the time. All we had to do was reverse the thrust, back off, and go around the sand bar.

Toward late afternoon we turned up one of the few vulnerabilities of a jet. The water was liberally sprinkled with driftwood. A stick of just the right size got into the pump and wedged between the impeller blades. Only a certain size causes trouble—larger ones are kept out by an intake grate and smaller ones flow right on through. It doesn't jam the pump or do any permanent harm. It simply disturbs the water flow and causes you to lose thrust. The fix is simple: Kill the engine, open an inspection plate accessible from inside the boat, reach in, and pull out the stick.

A soggy lesson. A good wetting taught us how important it is for jet drivers to be good neighbors. At our second night's camp, the other jet was tied upstream from us. As they backed off the sand bar, and before the driver could shift to forward, the strong current swept him dangerously close to us. Worse, about 30 feet offshore and slightly below our boat there was a giant boulder. With his stem only a few feet from us, he panicked and shoved the throttle to the wall, squirting water into our boat at a rate of some 3,000 gallons per minute. It was like being on the receiving end of a fire hose.

During our last day out, I switched to the other jet boat for a while. It was an aluminum-hulled craft of about the same size as our test boat but with somewhat different lines. It didn't have quite the pep of our boat, but the strong tendency to lead was absent. I satisfied myself that this characteristic was not the fault of the jet drive.

After three jet-propelled days through fairly rugged water, I have to agree with Arnold Feller's words in the opening sentence. The last glimpse I had of him, he was doodling plans for a jet boat he wants for next season. ■■

Dry Run to Venus

[Continued from page 98]

Matching Old Sol. To imitate the sun, there's candlepower enough to illuminate two Rose Bowls and mirrors enough to equip a major telescope.

In a housing above the vacuum chamber, there's a battery of 131 mercury-xenon lamps, the most powerful ever made. Altogether, they burn 375 kilowatts of electricity, generating 200 kilowatts of heat while producing 175 kilowatts of light.

These mercury-xenon lamps have no known commercial use. They were chosen as a stand-in for the sun because they duplicate nearly all the visible and invisible rays in sunlight. But it is also essential that their light fall on the spacecraft below in a collimated beam—one in which the rays are parallel, as they are in sunlight.

To accomplish this, the light is first bounced between mirrors within the lamp housing. It is then beamed through a three-foot quartz lens in the ceiling of the vacuum chamber. Below, it is bounced once more between mirrors and finally descends upon the spacecraft in a 12-foot-wide collimated beam. Later, this will be broadened to 25 feet.

The brightness of the beam can be varied, of course, to simulate the intensity of sunlight on the surface of a probe traveling anywhere in our solar system.

In an ordinary vacuum chamber, heat radiated by the spacecraft in the beam of light would be reflected by the walls. That would create a temperature rise that couldn't occur in the icy black void of outer space. It doesn't happen in JPL's space simulator, either.

The walls of its vacuum chamber, a shroud of 200 black aluminum plates, are veined with little tubes circulating liquid nitrogen cooled to 310 degrees F. below zero. (Waste gas is blown through the lamp housing to keep that unit cool.)

This system absorbs 99 percent of the heat radiated by the spacecraft, and closely imitates the environment of a man-launched probe as it speeds on its way to another planet. ■ ■

Why Does a Pump Pump?

[*Continued from page 110*]

output pressure is to pump the liquid several times. Two or more impellers are mounted on the same shaft. Liquid is forced from one discharge to the next eve and gets a pressure assist at each stage.

Rotary pumps. Transporting a fluid is an important part of a pump's job. A no less important part is getting rid of it at the right time and in the right place. Centrifugals do this by hurling their load out the discharge port. Reciprocating pumps, in general, simply drop each scoopful out

Since many types of rotary pumps have vaned impellers, they bear a surface resemblance to centrifugals. But there's a basic difference. Rotary impellers work by positive displacement — they scoop liquid in fixed, separate gobs. They do not impart centrifugal force to sling the liquid out. Because they don't, part of the liquid they carry may tend to remain pocketed between the vanes or teeth and be carried back to the intake side of the pump.

Modern rotary pumps use a bag of ingenious tricks to keep this from happening. One of the neatest is found in the gear pump. Typically, two side-by-side spur gears are closely fitted to each other and to their housing. Liquid is caught between the gear teeth and carried to the outlet. At this point, the teeth mesh for the return trip so the liquid has no place to go but out.

In rotaries that have only a single impeller, other discharge means are needed. The most common consists of mounting the impeller off-center. This makes the forward passage larger than the return and thus forces out liquid before it can be carried back. Flexible vanes or rollers permit the impeller to be mounted off-center

The helical. One of the newest rotary designs, called a helical, has a long, screw-like rotor that spins inside a closely fitting flexible housing. As the rotor turns, its spiral ridges form a series of moving pockets inside the housing that carry the liquid forward. Since the pockets move only in one direction and disappear at the end of the rotor, the liquid can't flow back.

So one of the latest advancements in pumps actually comes around full circle to one of the oldest—Archimedes' screw. And that's the story of pumps—ageless principles constantly refined and improved to produce a modern tool so vital that very little today would work without it. ■ ■

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The following booklets, of special interest to POPULAR SCIENCE readers, are offered either free or at small charge by the source listed with each. Please order direct—not from POPULAR SCIENCE.

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Big Revolution in Boat Shapes

[Continued from page 115]

other, so they don't swerve or broach in a heavy sea.

But turbulence between the hulls of a cat loosens the bite of a centered prop, making an engine on each pontoon necessary for most cats. The trimaran, with a centered third pontoon, can carry a single engine, as can the dual cathedral. Hull prices for all three types start around $600.

The three-pointer: a tamed wildcat. The three-point hull, strictly a racing specialist until recently, has always had qualities that lured designers to tame it as a family pet. Wide-track sponsons give it dock steadiness. And, instead of planing only at the stern, it planes on two forward steps plus the after hull. This reduces chance of the rhythmic up-and-down "porpoising" of the bow that bugs fast single-plane hulls when they're poorly trimmed with too much weight aft.

A narrow V-section added between the sponsons, like that Outboard Marine uses on its sleek new 17-footer, increases bow lift and cushions wave impacts in rough water—something all-out racers didn't need because they stayed home when the weather acted up. Three-point prices range from around $795 for hull only to around $3,200 complete with luxuries and an outdrive.

What about displacement hulls? In addition to Bertram's high-planing V hull, several other companies, such as Glastron, either already have, or will soon come out with, similar hulls using a form of stepped strakes to provide lift.

Otherwise, conventional deep-riding V hulls are tightly limited by proven physical laws. Multiply the square root of its waterline in feet by 1½ and you get its "critical speed" in knots. Push it beyond that point and the suction that holds its back will drag the stern down—often enough to swamp it with its own following wave.

But a new day may be dawning for the old displacement hull. Nature's playful porpoise is able to travel well beyond its critical speed because it has a drag-reducing skin that undulates with the eddies.

The U. S. Rubber Co. has come up with a pretty fair copy called Lamiflo for possible boat use. It cut drag on a test torpedo form by 50 percent. Later, it did almost as well on a runabout. Now the Navy is working on it under wraps. But some day you may break speed records in a boat that's soft and wiggly. ■■

How to Track Down TV Interference

[*Continued from page 124*]

you can pull in both. Channel 3 has a tendency to interfere with 4, and 10 tends to work in 11's area. Reason: The frequency allocations of these channels do not allow a comfortable margin of separation.

Adjacent-channel trouble is recognizable by a herringbone overlay, a windshield-wiper effect, or both. The herringbone is the adjacent sound and the wiper is the adjacent picture

Reduce this type of TVI with a super-antenna and motor, or with a good trap (discussed later). A last resort is to have your TV realigned, sacrificing some picture quality for sharper separation.

Woes brought on by neighbors. An oscillator in a nearby electronic industrial heater, diathermy machine, or ham radio can mess up your picture.

This TVI makes its appearance as an overlay pattern. The overlay can cover the screen or appear as horizontal bars. If it's persistent, you can track down the interference by taking two bearings. Connect a TV antenna to your TV set. Rotate the antenna till the TVI shows up strongest.

On a street map, mark off the TV set's location. Draw a line through the location in the direction of strongest pickup. Travel to another TV a few blocks away. Set up and shoot another bearing. Draw a direction line through the second location on the map. Where the two lines cross is the site of the illegal transmission. From then on it's a matter of diplomacy or a report to the FCC

Radio-frequency TVI. Remedies for noise must be applied at the TVI source, but RF cures can be carried out at the television set. You trap the offending frequency with a stub.

I stub this way: I attach eight feet of twin lead to the antenna terminals on top of the aerial connection. Then, watching the TVI on the screen, I short the wires with a sharp knife. I start about 13" from the terminal and, in 1" steps, cut through the insulation and short the twin lead. At a few spots the interference is reduced. I mark those spots.

At the best spot I try ½" steps till I find the ideal trap length. Then I cut the wire about ½" longer, strip the insulation, and twist the wires together. Sometimes you'll only want the trap installed for certain stations. A clothespin-type connector provides an easy on-and-off. ■ ■

[Continued from page 74]

sightedness, or any other eye problem since the advent of television. Watching television—and motion pictures, too—is actually good eye exercise, Dr. Kaplan maintains.

He says it's also a misconception that eyesight can be damaged by holding reading material close to the eyes or by reading while lying down. Such use of the eyes may cause discomfort, but the eyes themselves will not be harmed.

What's the best way to use your vision in driving?

Keep your eyes moving—and make full use of your side vision.

Side vision, although not sharp, is very quick to note lights and movement. Much of what you see when you drive should first be detected by it.

But when you concentrate your eyes on one subject—focus them on it for longer than about two seconds—you begin to stare blankly. And in staring you lose side vision.

Staring is believed to account for many accidents. Thus a cardinal rule for good driving is to force your eyes to move at least every two seconds. Don't look at just one spot on the road; look near and far ahead, to both sides, and into the rear-view mirror.

Is it a good idea to wear sunglasses?

If you need them. Some people aren't bothered by the sun's rays—even on a beach. But note this: While sunglasses cut glare, they don't give you any license to stare at the sun. The harmful ultraviolet rays can burn your retinas through the darkest glasses. And don't wear sunglasses while driving at night. They may cut down glare from oncoming headlights—but they also dim objects along the edge of the road.

What forms does color blindness take—and can anything be done about it?

In one type, all colors of the spectrum can be recognized but there's great difficulty in distinguishing between shades of the same color. In another type, relatively rare, there is virtually no color sensation at all; only shades of gray are seen.

There is no cure for color blindness. Color-blind people can get by in traffic because some gifted (or possibly color-blind) engineer instituted a system of traffic lights, now almost universal, with the red at the top and the green at the bottom.

What can be done about night blindness?

Certain cells in the retina of the eye—they're called rods—have a special pigment that makes them effective in dim light and at night. The body produces the pigment from vitamin A. It can also produce it from carotene, a substance in such foods as carrots and yellow corn. Often, inability to see well at night results from insufficient intake of carotene or vitamin A—and increasing the intake of one or the other solves the problem.

Do drinking and smoking affect vision?

A heavy drinking bout can make you see double temporarily because alcohol relaxes the muscles that coordinate the eyes. Working separately, instead of together, they then see two images.

Excessive smoking and drinking sometimes diminish visual acuity and produce dark, cloudy patches before the eyes. This is called toxic amblyopia—and elimination or reduction of smoking and drinking may gradually restore normal vision.

What is glaucoma? Cataract?

These are two of the major causes of blindness—and need not be. Both diseases can attack younger people but much more often strike after the age of 40

In glaucoma, fluid pressure inside the eye increases. There is an acute type that comes on suddenly, causing cloudy vision, usually with a sharp pain in and

around the eyes. The chronic type, however, is more common—and creeps up slowly and painlessly. It may produce only vaguely disturbing symptoms such as inability of the eyes to adjust well to darkened rooms or occasional fogginess and blurring of vision.

If glaucoma is not arrested, pressure finally destroys sight. The best defense is an examination at least once every two years after the age of 40. Pressure within the eye can be measured with a special instrument.

A cataract is a clouding of the lens so that light rays are partly or completely prevented from getting through to the retina. If the cloudy area is small and vision is not severely hampered, there may be no need for treatment, although the condition should be checked from time to time by a doctor.

Where cataract does interfere with seeing, the cloudy lens can be removed and special glasses or a contact lens used to replace it.

How good are contact lenses now?

They're increasingly effective and millions wear them. But they take some getting used to—and some people never adjust.

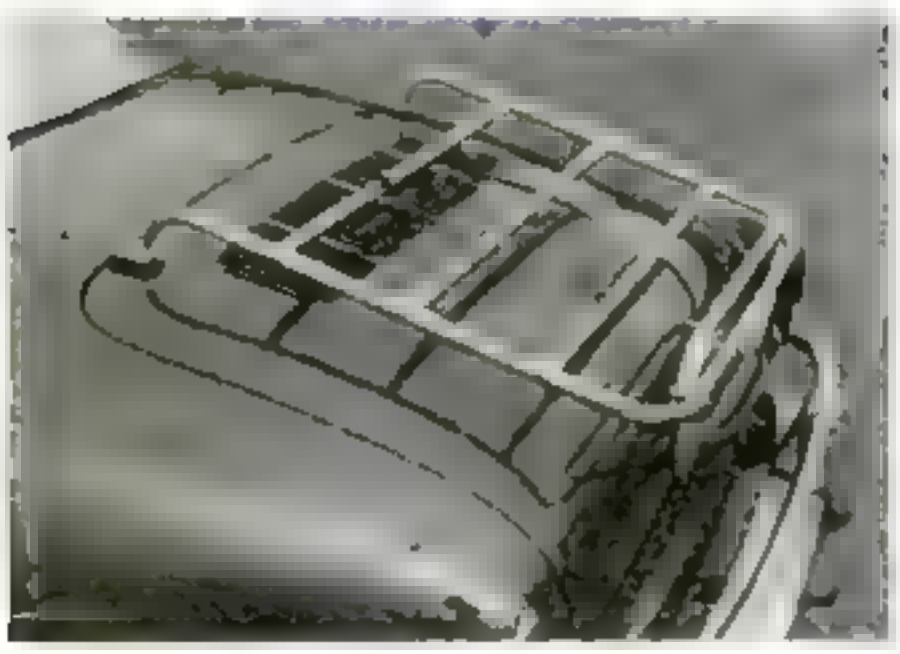
The lens now in widest use is the tiny corneal type which measures less than one-third of an inch in diameter and covers only 60 percent of the window of the eye. It floats on the eyes' natural tear layer and is held in place by capillary attraction.

Most people who wear contact lenses do so for appearance. There are also policemen, seamen, and other outdoor workers who like them because wind and weather do not affect the lenses.

If you're interested in contact lenses, they'll represent a considerable investment of money—from $150 to $300—and of time and trouble getting used to them. There are all kinds of contact-lens fitters. Some are qualified and ethical; others are not. Be wary of advertising that says anyone can wear the lenses after one or two visits. ■■

what's new .....for your CAR

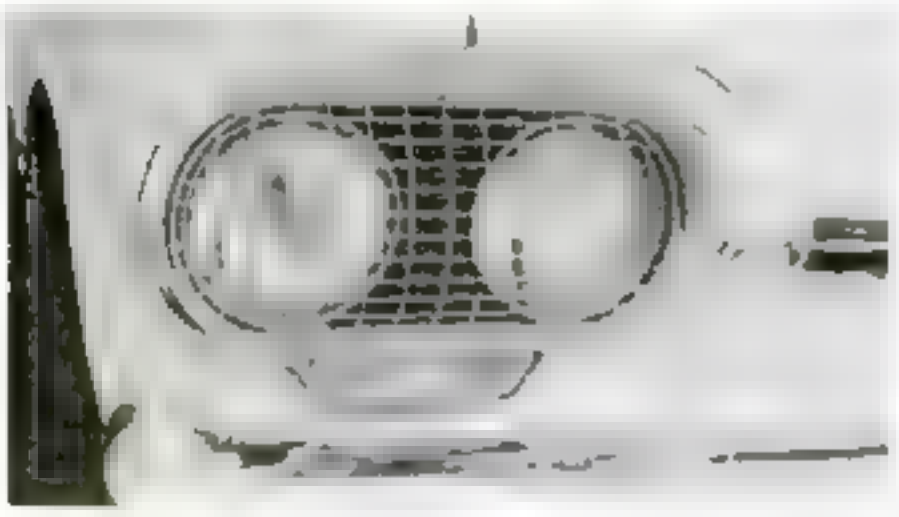
[Continued from page 137]



Removable rack doesn't scratch paint

These aluminum luggage racks fasten without drilling or suction cups. Karmann-Ghia model shown has rubber-faced clamps that grip trunk-lid edge. Some models mount to hinges and handles. Racks are available for Corvair, Corvette, Volvo P-1800, Caravelle, Mercedes 190SL, Sunbeam Alpine, and Jaguar from Cunell Co., 61 South St., Box 16, Hackensack, N.J. Car dealers sell racks for BMC and Triumph sports roadsters. Price: $28.50 and up.

▶▶▶ A prismatic plastic lens, called Lite-Site, brings hard-to-see overhead traffic signals within the driver's range of vision. A magnet imbedded in the lens allows easy mounting and adjustment on metal windshield trim. H. F. Carlson, 252 Walper Ave., Clawson, Mich. $1.49, postpaid.



Corvair headlights protected by grille

Chromed headlamp guards are among two dozen new customizing accessories offered for Corvairs. They come with mounting screws from Eelco Mfg. Co., 308 E. Beach Ave., Inglewood, Calif., at $11.95 a pair.

Year-Round Play Court for Your Back Yard

[Continued from page 128]

the edges of the paving so as not to endanger roller skaters. If you incorporate the tether-ball court, you'll have to sink a socket flush with the asphalt surface for the 9′ pole. This might be nothing more than a galvanized coupling embedded in concrete, but it will need a cap that screws flush when the post isn't in place. The cap should have lugs or slots for easy removal. Paint a red circle around it to warn skaters.

When winter comes, there are several ways to add the ice-rink feature. Cheapest would be the clear-plastic-sheet treatment shown in our sketch. You can buy a 20′-wide, 50′ roll of 4-mil polyethylene for under $12 from Sears or other suppliers. It should last several seasons.

Or your contractor may assure you that the paving itself is impervious enough to allow direct flooding. Then you could have an asphalt curb run around the edges to form a permanent flooding basin. There's a special gasoline-driven machine for this job; hot mix is poured into the hopper and as the rig moves along, it leaves behind a properly compacted curb of the selected size and shape. No forms are required. The cost: about 50 to 70 cents a lineal foot.

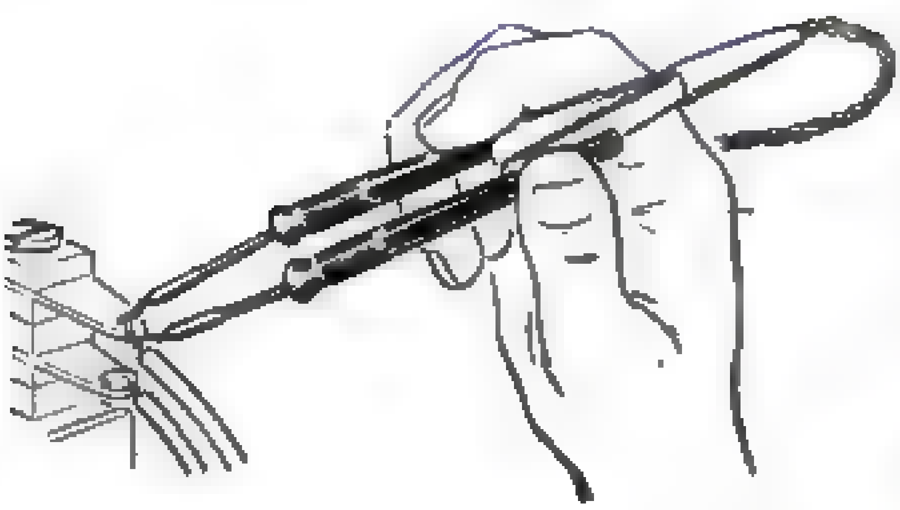
In either case, you'll want to lighten the color of the surface. Natural black asphalt absorbs heat to the extent that even a weak winter sun could prevent solid freezing. To make the surface *reflect* heat, you can paint it with a light-colored latex or plastic-base material—or you can broom on a water-diluted lime slurry, which dries white and will last through the winter.

One of asphalt's big advantages is that it goes down fast. A top-efficiency crew might lay a badminton court in two days. And there's no curing period. Since kids will be rarin' to go when the play plot is this near completion, it's good to know that the pavement is ready for use almost immediately after it's laid.

There's no wait, either, for it to dry after a cloudburst. While the rest of the yard's soggy, you can romp through a game of ring tennis without getting your feet wet. Asphalt is not affected by frost—nor ice-melting salts, should you want to keep the area clear during the winter. And it stays resilient, which means less foot and leg fatigue. In case it needs smoothing after several years, an inexpensive fog coat will make the surface good as new. ■ ■

what's new ....TOOLS

[Continued from page 139]



Tweezers double as soldering iron

Each leg of these 6" tweezers is a soldering iron. Heating both sides of the joint speeds the job and assures uniform bond while holding the work rigid. The tool draws its six-volt power from a battery, or through an accessory transformer ($5.45). Imported by Oryx, P. O. Box 368, Scottsdale, Ariz., it sells for $14 95.

►►►C clamps molded of glass-filled nylon won't rust, mar wood surfaces, or draw off heat or current in soldering or electrical work. Set of three (3/4", 1 5/16", and 2" openings) is $2 98 ECI Clamp Div., 84-43 Abingdon Rd., Kew Gardens, N.Y.

One-hand power veneer trimmer

Do much work with counter-top laminates or veneers? Here's a tool that trims flush or bevel, vertically or horizontally. No scribing is needed when a top must fit against an irregular wall; a guide slides along the wall as the tool cuts. Under-edge bearing guide comes off to convert tool to a high-speed router. Stanley Power Tools. $85.

►►►For lubrication or electrostatic shielding, you can now spray graphite from an aerosol can, applying 7- to 10-micron particles to any desired thickness Sample 16-oz. Aerodag can: $3. Primitive Products, 180 Linwood Ave., Fairfield, Conn

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